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(54)【発明の名称】　セルラ通信システム、及びそれに用いられる移動機と基地局

(57)【特許請求の範囲】

【請求項１】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムであり、

前記移動機は、

前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタする下り受信品質モニタ手段と、

前記複数の下り受信品質モニタ結果に従って送信すべき基地局を指示する信号を送出する基地局指定手段と、

前記基地局指定信号を上り信号に多重化して前記複数の基地局に送信する多重化手段と、

前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含み、

前記基地局は、

前記上り信号に多重化された基地局指定信号を復調する復調手段と、

前記復調された基地局指定信号に従って、該当する移動機への下り送信信号の送信を制御する送信制御手段とを含むセルラシステム。

【請求項２】前記移動機の下り受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項１記載のセルラシステム。

【請求項３】前記基地局の送信制御手段は、基地局指定信号が自基地局では無い場合に送信を停止する請求項１記載のセルラシステム。

【請求項４】前記基地局の送信制御手段は、基地局指定信号が自基地局の場合および基地局指定信号に伝送誤りを検出した場合に送信を行う請求項３に記載のセルラシ

ステム。

【請求項５】前記移動機の基地局指定手段は、複数の基地局の下り受信品質の差があらかじめ決められた値より小さい場合に、複数の基地局を指定することを特徴とする請求項１に記載のセルラシステム。

【請求項６】前記移動機の基地局指定手段は、すべての基地局の下り受信品質があらかじめ決められた値より小さい場合に、複数の基地局を指定することを特徴とする請求項１に記載のセルラシステム。

【請求項７】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムに用いられる移動機であり、

前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタする下り受信品質モニタ手段と、

前記複数の下り受信品質モニタ結果に従って送信すべき基地局を指示する信号を送出する基地局指定手段と、

前記基地局指定信号を上り信号に多重化して前記複数の基地局に送信する多重化手段と、

前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含む移動機。

【請求項８】前記移動機の下り受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項７記載の移動機。

【請求項９】前記基地局の送信制御手段は、基地局指定信号が自基地局では無い場合に送信を停止する請求項７記載の移動機。

【請求項１０】前記基地局の送信制御手段は、基地局指定信号が自基地局の場合および基地局指定信号に伝送誤りを検出した場合に送信を行う請求項９に記載の移動機。

【請求項１１】前記移動機の基地局指定手段は、複数の基地局の下り受信品質の中で最良品質を示す基地局とこの最良品質との差があらかじめ決められた値より小さい基地局を指定することを特徴とする請求項７に記載の移動機。

【請求項１２】前記移動機の基地局指定手段は、すべての基地局の下り受信品質があらかじめ決められた値より小さい場合に、複数の基地局を指定することを特徴とする請求項７に記載の移動機。

【請求項１３】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムに用いられる基地局であり、

前記移動機からの上り信号に多重化された基地局指定信号を復調する復調手段と、

前記復調された基地局指定信号に従って、該当する移動機への下り送信信号の送信を制御する送信制御手段とを含む基地局。

【請求項１４】前記基地局の送信制御手段は、基地局指定信号が自基地局では無い場合に送信を停止する請求項１３記載の基地局。

【請求項１５】前記基地局の送信制御手段は、基地局指定信号が自基地局の場合および基地局指定信号に伝送誤りを検出した場合に送信を行う請求項１４に記載の基地局。

【請求項１６】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムであり、

前記移動機は、

前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタし、モニター結果とそれに対応する基地局を示す信号とからなる副信号を出力する受信品質モニタ手段と、

前記副信号を上り信号に多重化して前記複数の基地局に送信する多重化手段と、

前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含み、

前記基地局は、

前記上り信号に多重化された副信号を復調する復調手段と、

前記復調された副信号に従って、自局の下り信号の送信を停止するか否かを示す送信停止信号を生成する送信停止信号生成手段と、

前記送信停止信号が送信停止を示しているときは、移動機への下り送信信号の送信を停止する送信制御手段とを含むセルラシステム。

【請求項１７】前記移動機の受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項１６記載のセルラシステム。

【請求項１８】前記基地局の送信制御手段は、前記副信号に誤りが検出されたときは、前記下り信号の送信を停止しない請求項１６に記載のセルラシステム。

【請求項１９】前記送信停止信号生成手段は、すべての基地局の下り受信品質があらかじめ決められた値より小さい場合には、自局の下り信号品質が所定の順位以上であるときには、前記送信停止信号を出力しないことを特徴とする請求項１６に記載のセルラシステム。

【請求項２０】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムに用いられる移動機であり、

前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタし、モニター結果とそれに対応する基地局を示す信号とからなる副信号を出力する受信品質モニタ手段と、

前記副信号を上り信号に多重化して前記複数の基地局に

送信する多重化手段と、
前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含む移動機。
【請求項２１】前記移動機の受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項２０記載の移動機。
【請求項２２】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムに用いられる基地局であり、移動機からの上り信号にその移動機とソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質のモニタ結果とそれに対応する基地局を示す信号とからなる副信号とが多重化された上り信号を受信する基地局であり、
前記副信号を復調する復調手段と、
前記復調された副信号に従って、自局の下り信号の送信を停止するか否かを示す送信停止信号を生成する送信停止信号生成手段と、
前記送信停止信号が送信停止を示しているときは、移動機への下り送信信号の送信を停止する送信制御手段とを含む基地局。
【請求項２３】前記送信制御手段は、前記副信号に誤りが検出されたときは、前記下り信号の送信を停止しない請求項２２に記載の基地局。
【請求項２４】前記送信停止信号生成手段は、すべての基地局の下り受信品質があらかじめ決められた値より小さい場合には、自局の下り信号品質が所定の順位以上であるときには、前記送信停止信号を出力しないことを特徴とする請求項２３に記載の基地局。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、移動通信システム、特に直接拡散符号分割多元接続（ＤＳ－ＣＤＭＡ）方式を用いた自動車電話・携帯電話システム（セルラシステム）のハンドオーバー技術に関し、属し、特に、移動機が複数の基地局と同時に接続されているソフトハンドオーバー時に、複数の基地局から移動機へ送信するための下り回線の送信電力制御技術に関する。
【０００２】
【従来の技術】本技術における従来技術としては、北米標準のＴＩＡ／ＥＩＡ　ＩＳ－９５に準拠した、符号分割多元接続（ＣＤＭＡ）方式を用いたセルラシステムが知られている。このＩＳ－９５標準では、ソフトハンドオーバーという技術が使われている。このソフトハンドオーバー技術が使用されるシステムでは、移動機がセル（またはセクタ）境界に近づいたときには、その移動機は、この境界近辺のセルをサービスエリアとする複数の基地局と同時に通信を行う
すなわち、移動機が現在通信中の基地局以外に受信レベルの大きい基地局を検出すると、移動機は自身がセル境界に近づいたと判断し、現基地局及び受信レベルが大きな他の基地局との複数の基地局との通信を開始する。そして、移動機は、複数の基地局から同じ下り情報を受信し、移動機では複数の基地局からの下り情報を最大比合成ダイバーシティ受信する。
【０００３】移動機の送信する上り情報は、複数の基地局で受信されてこれら複数の基地局を統括する基地局制御装置（ＢＳＣ；Base Station Contoller）に伝えられる。基地局制御装置は、これら複数の基地局で受信された上り信号を、最大比合成受信あるいは選択ダイバーシティ受信する。移動機がセル境界に位置するときは、基地局における上り信号の受信品質が低下するが、ＢＳＣにおいて複数の基地局の上り信号受信結果を合成あるいは選択ダイバーシティ受信することにより、この上り信号の受信品質低下を緩和できる。
【０００４】また、移動機がセル境界付近に位置すると、基地局からの距離が離れているので基地局からの下り信号の受信レベルが低下する。また、セル境界では、複数のセルからの干渉を受けるため回線品質が劣化しがちであるが、このように複数の基地局と接続する（ソフトハンドオーバー）ことにより、下り回線品質の劣化を防ぐことができる。
【０００５】
【発明が解決しようとする課題】しかしながら、ＩＳ－９５等の従来技術では、ソフトハンドオーバー中は、複数の基地局から下り信号を同時に送信していたため、ソフトハンドオーバー技術を使用しないセルラーシステムに比して、使用中の下り回線数が著しく増加する。すなわち、ソフトハンドオーバー中の移動機の台数が増えると、下り回線容量がネックとなって同時使用できる回線数が制限されるため、回線の有効利用が計れなくなるという潜在的な問題があった。
【０００６】しかるに、ＩＳ９５では、下り回線の伝送方式の方が上り回線の伝送方式に比べて効率が良かったため、上記のような複数の基地局から下り信号を送信するという、一見すると、非効率的な方法を用いても、下り回線容量がネックになることはなかった。
【０００７】しかし、現在、上り回線容量が下り回線容量と同等に改善されつつあるため、ソフトハンドオーバーによる下り回線容量の劣化を解決する必要が生じている。
【０００８】それ故に、本発明の主たる目的は、ＣＤＭＡ方式を採用した移動通信システムにおいて、セルあるいはセクタ境界に位置する端末に対するソフトハンドオーバー中の下り送受信方式を改良することにより、下り回線の効率を向上することができるソフトハンドオーバー方式を提供することにある。
【０００９】
【課題を解決するための手段】本発明は、直接拡散符号

分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムであり、前記移動機は、前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタする下り受信品質モニタ手段と；　前記複数の下り受信品質モニタ結果に従って送信すべき基地局を指示する信号を送出する基地局指定手段と；　前記基地局指定信号を上り信号に多重化して前記複数の基地局に送信する多重化手段と；　前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含み、前記基地局は、前記上り信号に多重化された基地局指定信号を復調する復調手段と；　前記復調された基地局指定信号に従って、該当する移動機への下り送信信号の送信を制御する送信制御手段；とを含む。

【００１０】移動局はハンドオーバー中の複数の基地局からの下り信号の品質をモニタし、品質の最も良い基地局を指定する信号を上り信号に多重化して送り返すことにより、ハンドオーバー中でも回線状態の良い基地局のみ下り送信を行い、その他の基地局の送信を停止することが可能となり、下り回線の周波数利用効率を高めることができる。

【００１１】

【発明の実施の形態】次に本発明につき、図面を参照しながら説明する。

【００１２】図１は本発明に係る第１の実施形態に係る移動機の構成を示すブロック図、図２は本発明にの第１の実施形態に係る係る基地局の構成を示すブロック図である。

【００１３】図１に示されるとおり、本発明の第１の実施形態に係る移動機は、１または複数の基地局から無線信号を受信するアンテナ１０１と；送受共用器（デュープレクサ；ＤＵＰ）１０２と、無線信号を受信ベースバンド信号に変換する無線受信部（Ｒｘ）１０３と；ハンドオーバー中の複数の基地局のパイロット信号を受信し、受信品質をモニタする受信品質モニタ手段１０４と；複数の基地局の下り回線品質のモニタ結果から、受信品質の良い基地局を選択し、この受信品質の良い基地局に対応する基地局指定信号（ＢＳｓｅｌ）を出力する基地局指定手段１０５と；、この基地局指定信号（ＢＳｓｅｌ）を含む付随制御チャネルと上り通信チャネルデータ（ｒ－ｔｘｄ）を多重化し上り送信信号を生成するマルチプレクサ（ＭＵＸ）１０９と；上り送信信号を拡散し、送信ベースバンド信号を出力する拡散回路１１０と；送信ベースバンド信号を無線信号に変換して送信する無線送信部（Ｔｘ）１１１と；ハンドオーバー状態にある複数の基地局からの受信ベースバンド信号を合成受信するＲＡＫＥ受信機１０８とにより構成されている。

【００１４】ＲＡＫＥ受信機１０８は相関器１０６と、下り通信チャネルデータ（ｆ－ｔｘｄ）を出力する最大比合成器１０７とを有している。

【００１５】移動機の下り受信品質モニタ手段１０４は、基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定する。

【００１６】基地局指定手段１０５は、複数の基地局の下り受信品質が良い基地局を選択し、選択された基地局を示す基地局指定信号を出力する。この選択の基準としては、例えば、次の基準のいずれでも使用することができる。

（１）最良の受信品質を示す基地局と、この最良の受信品質との差が小である基地局とを選択する。

（２）受信品質の良い順に、現在ハンドオーバー対象となっている基地局の数以下の所定数の、基地局を選択する。

（３）受信品質が予め定められた値よりも大きな基地局を選択する。ただし、全ての基地局の受信品質が全てこの予め定められた値より小さい場合には、受信品質の良い順に所定数の基地局を選択する。この付加的な条件は、ソフトハンドオーバー状態にある全ての基地局の、移動機での下り信号受信品質が低い場合に、全ての基地局が送信停止してしまうことを防止するために設けられている。

【００１７】図２を参照すると、本発明の第１の実施形態に係る基地局は、複数の通信チャネルで共通に利用する共通部と、通信チャネル毎に分かれたチャネル部２０８とに分けることができる。

【００１８】共通部は、移動機からの無線信号を受信するアンテナ２０１と、送受共用器（デュープレクサ；ＤＵＰ）２０２と；無線信号を受信ベースバンド信号に変換する無線受信部（Ｒｘ）２０３と；パイロットチャネル（ＰＬＣＨ）を拡散する拡散回路２１８と、パイロットチャネルおよび複数のチャネル部２０８からの複数のチャネルの送信信号を加算合成する加算器２０９とで構成される。これら、パイロットチャネルと複数の通信チャネルとでは、使用される拡散符号が異なっている。

【００１９】通信チャネル毎に必要なチャネル部２０８は、マルチパス伝搬路を経由した受信信号を逆拡散して最大比合成するＲＡＫＥ受信機２０４と；ＲＡＫＥ受信機２０４出力から上り通信チャネルデータ（ｒ－ｒｘｄ）と基地局指定信号（ＢＳｓｅｌ）を含む付随制御チャネルとを分離するデマルチプレクサ（ＤＭＵＸ）２０５と；下り通信チャネルデータ（ｆ－ｔｘｄ）を拡散する拡散器２０６と、移動機からの付随制御チャネルデータに含まれている基地局指定信号（ＢＳｓｅｌ）に従って、送信のＯＮ／ＯＦＦを制御する送信制御手段２０７と、により構成されている。

【００２０】次に本発明の第１の実施の形態例の動作について図３を参照して説明する。図３はこれから説明するソフトハンドオーバー動作を行う時の移動機の動きを示す図である。

【００２１】移動機（ＭＳ）３０３が、基地局（ＢＳ１）３０１のサービスエリアから基地局（ＢＳ２）３０２のサービスエリアに移動し、２つの基地局３０１，３０２のサービスエリアが重なる部分に位置すると、基地局（ＢＳ２）３０２は、移動機からの上り信号が受信可能となり、基地局（ＢＳ２）３０２は、移動機３０３からの上り信号の受信が可能になった旨を基地局制御装置に伝える。すると基地局制御装置は、基地局（ＢＳ１）３０１からの上り信号と基地局（ＢＳ２）３０２からの上り信号とを最大比合成受信あるいは選択ダイバーシティ受信して、その結果を移動通信用交換機（ＭＳＣ）に転送する。また、基地局制御装置は、それまで基地局（ＢＳ１）３０１にのみ伝えていた移動通信用交換機から移動機３０３への下り信号を、基地局（ＢＳ２）３０２にも転送する。この動作については、ＩＳ－９５標準等に規定された従来技術と同様である。

【００２２】次に、本発明の根幹をなす、移動機及び基地局の下り信号に対する動作につき説明する。この図３の例では、前述した選択基準は、全て一致することとなり、良い受信品質を示した方の基地局のみが選択され、選択されなかった基地局は、移動通信用交換機（ＭＳＣ）、基地局制御装置（ＢＳＣ）を介して供給された下り信号の送信を停止する。

【００２３】基地局３０１、３０２の送信制御手段２０７は、基地局指定信号が自基地局を指定していない場合には、送信を停止する。また、送信制御手段２０７は、基地局指定信号が自基地局を指定している場合および基地局指定信号に伝送誤りを検出した場合に移動機への送信を行い、それ以外の場合に送信を停止する。

【００２４】図４は、この時の基地局３０１および基地局３０２の下り受信品質の遷移、および、各基地局（ＢＳ１，ＢＳ２）３０１，３０２の送信ＯＮ／ＯＦＦのタイミングを示すタイムチャートである。

【００２５】従来方式（例えばＩＳ９５）では、図４ａ）、ｂ）に示されるとおり、２つの基地局の受信品質差が一定値より小さくなるとソフトハンドオーバー状態に入り、２つの基地局で移動機に送信を開始する。このソフトハンドオーバー状態は、２つの基地局の受信品質差が一定値以上に開き、完全に新しい基地局（ＢＳ２）３０２のサービスエリアに入るまで継続される。すなわち、従来例では、ソフトハンドオーバー中は２つの基地局で送信を行っている。

【００２６】一方、図４ｃ）～ｅ）は本発明の一実施例における、基地局指定信号および２つの基地局（ＢＳ１，ＢＳ２）３０１，３０２の送信ＯＮ／ＯＦＦのタイミングを示している。ハンドオーバー中も受信品質の変化に伴って、基地局指定信号が変化し、常に伝搬状態の良い片方の基地局からのみ送信が行われることを示している。

【００２７】この図３の例における、ソフトハンドオーバーの手順は次の通りである。

［１］従来技術と同様に、移動機３０３は周辺基地局のパイロットチャネルの受信品質を測定し基地局に報告する。現在通信中の基地局のパイロットチャネルの受信品質と一定差以内の基地局が検出されると、ソフトハンドオーバー状態に入る。

［２］基地局より、ソフトハンドオーバー状態の基地局とその番号を移動機に通知する。

［３］ソフトハンドオーバー状態の複数の基地局は、従来と同様、移動機の上り情報を最大比合成あるいは選択ダイバーシティ受信する。

［４］移動機はソフトハンドオーバー状態の基地局のパイロットチャネルの品質をモニタし、最も品質の良い基地局の番号を上り回線の付随制御チャネルを用いて、ソフトハンドオーバー状態の全基地局に通知する。品質測定・通知は、レイリーフェージングに追従する必要はなく、建物の陰に入る等の伝播経路の変化（シャドウイング）に追従できればよい。

［５］移動機３０３に指示された基地局のみ下り情報を送信する。上り回線の誤り等により、１局も下り情報を送信しない危険があるが、付随制御チャネルのＣＲＣで誤りを検出した基地局でも送信する等の方法により避けることが可能である。

［６］移動機３０３は複数の基地局からの信号を選択あるいは最大比合成により受信する。

［７］パイロットチャネルの受信品質の差が一定値以上になったときは、ソフトハンドオーバ状態を解除する。

【００２８】このような手順で基地局および移動機３０３が動作する事により、ソフトハンドオーバー状態でも、伝搬品質の良い一部の基地局のみが、下り送信を行うことになり、伝搬品質の悪い基地局からは下り送信を行なわなくて済むため、下り回線の周波数利用効率を改善することができる。

【００２９】移動機３０３は、基地局サーチおよび同期検波を行うために、基地局毎に全回線で共通利用するパイロットチャネルを用いて下り回線品質の測定を行うため、送信停止状態の基地局の下り回線品質もモニタ可能である。したがって、移動機は、その移動機に対する下り通信を停止している基地局に、下り送信の再開をしじできる。

【００３０】複数の基地局の下り回線品質がほぼ同等で、最大比合成により複数の基地局からの受信信号を無駄なく合成可能と判断した場合は、移動機３０３は該当する複数の基地局に対して下り送信を指示することにより、ダイバーシティゲインを得ることも可能である。

【００３１】また、すべての基地局の下り回線品質がすべて劣化しており、１局の送信では所要品質を満たすことができないと判断した場合は、移動機は受信品質が比較的良い複数の基地局に対して下り送信を指示することにより、所要受信品質を得ることが可能である。

【００３２】移動機３０３の送信する基地局指定信号の受信を誤ることを想定しなければならない。特にソフトハントオーバーが複数の基地局にまたがる場合、各基地局の復調結果が異なり、どの基地局も送信指示されていないと判断する可能性がある。このようなケースを避けるため、復調結果に誤りを検出した場合は自局の送信が指示されていない場合にも送信することにより、すべての基地局が送信しない確率を非常に小さくすることができる（上記手順［５］）。

【００３３】しかしながら、複数の基地局で基地局指定信号の復調結果が同一であると保証できる場合は、誤り検出の有無に関わらず、基地局指定信号の通りに送信をＯＮ／ＯＦＦすればよい。例えば、ソフトハンドオーバーが１基地局内の複数のセクターの場合は、基地局指定信号の復調結果をセクタ間で共通とすることが容易に可能であるから、基地局指定信号の通りに送信セクタを選択しても良い。

【００３４】次に、図５及び図６を参照して、本発明の第２の実施形態を説明する。図５は、本発明の第２の実施形態に係る移動機の構成を示すブロック図であり、図６は、本発明の第２の実施形態に係る基地局の構成を示すブロック図である。

【００３５】図１と図５との比較から明らかなように、第２の実施形態の移動機は、第１の実施形態が備えていた基地局指定手段１０５を備えていない。その代わりに、第２の実施形態に係る移動機では、当該移動機が受信可能な基地局のパイロット信号の受信品質モニターのモニター結果が、対応する基地局を特定する信号とともにマルチプレクサ１０９に供給される。マルチプレクサ１０９ａは、受信品質モニター出力と上り通信チャネルデータ（ｒ－ｔｘｄ）を多重化し上り送信信号を生成し、拡散回路１１０に供給する。図５のその他の構成要素の動作は、図１に示した移動機と同様である。

【００３６】また、図２と図６との比較から明らかなように、第２の実施形態の基地局は、ＲＡＫＥ受信機２０４と送信制御手段２０７との間に、ＲＡＫＥ受信機２０４出力から「上り通信チャネルデータ（ｒ－ｒｘｄ）」と移動機（図５）が検出したパイロット信号の受信品質及びそれに対応する基地局を特定する信号」とを分離するデマルチプレクサ（ＤＭＵＸ）２０５と；これら受信品質及びそれに対応する基地局を特定する信号から、パイロット信号を除く自局の送信を停止するか否かを示す送信停止信号を生成し送信制御手段２０７に供給する送信停止信号生成手段１０５ａとを備えている。なお、この送信停止信号生成手段１０５ａの構成・動作は、図１の基地局指定手段と同様である。また、図６に於いて、説明を省略した構成要素の動作は、図２で同一参照符号を付したものと同様である。

【００３７】以上の説明から明らかなように、第１の実施形態と第２の実施形態とは、次の点で異なっている。第１の実施形態では、ソフトハンドオーバー時に、どの基地局の下り送信を停止させるかの決定は移動局側が決定していた。これに対して、第２の実施形態は、ソフトハンドオーバー時に、どの基地局の下り送信を停止させるかの決定は基地局が行っている。この第２の実施形態では、第１の実施形態で不可欠であった、移動機（図１）の基地局指定手段１０５が不要となるので、移動機を第１の実施形態よりも小型化できる。また、移動機の消費電力も、第２の実施形態の方が、第１の実施形態よりも小とすることができる。

【００３８】なお、第２の実施形態の送信停止信号生成手段１０５ａが送信停止信号を出力する基準としては、例えば、次の３つのいずれかを用いることができる。

（１ａ）自局の移動機での下り信号受信品質が、最良の受信品質を示す基地局の下り信号受信品質との差が大である場合に、送信停止信号を出力する。

（２ａ）自局の移動機での下り信号受信品質が、受信品質の良い順に、所定の順位より下位であるときは、送信停止信号を出力する。

（３ａ）自局の移動機での下り信号受信品質が予め定められた値よりも小さな値のとき、送信停止信号を出力する。ただし、全ての基地局の受信品質が全てこの予め定められた値より小さい場合には、自局の受信品質が、受信品質の良い順に所定の順位より上位である場合には、下り信号受信品質が予め定められた値よりも小さな値であっても、送信停止信号を出力しない。この付加的な条件は、ソフトハンドオーバー状態にある全ての基地局の、移動機での下り信号受信品質が低い場合に、全ての基地局が送信停止してしまうことを防止するために設けられている。

【００３９】

【発明の効果】以上述べたとおり、本発明では、ソフトハンドオーバー中も最も受信品質の良い少数の基地局からのみ下り送信が行われるため、下り回線の周波数利用効率が損なわれない。従って、本発明の採用により、下り回線の容量がネックとなって回線容量が制約されることを回避することができる。また、本発明では、ソフトハンドオーバー状態であっても伝搬状態の悪い基地局は送信しないため、基地局の平均送信電力を下げることができ、基地局の送信パワーアンプを簡易化できる。

【図面の簡単な説明】

【図１】本発明の第１の実施形態に係る移動機の構成を示すブロック図である。

【図２】本発明の第１の実施形態に係る基地局の構成を示すブロック図である。

【図３】本発明のソフトハンドオーバー動作に入る移動機の動きを示す図である。

【図４】本発明および従来例における受信品質と送信ＯＮ／ＯＦＦタイミングを示すタイムチャートである。

【図５】本発明の第２の実施形態に係る移動機の構成を

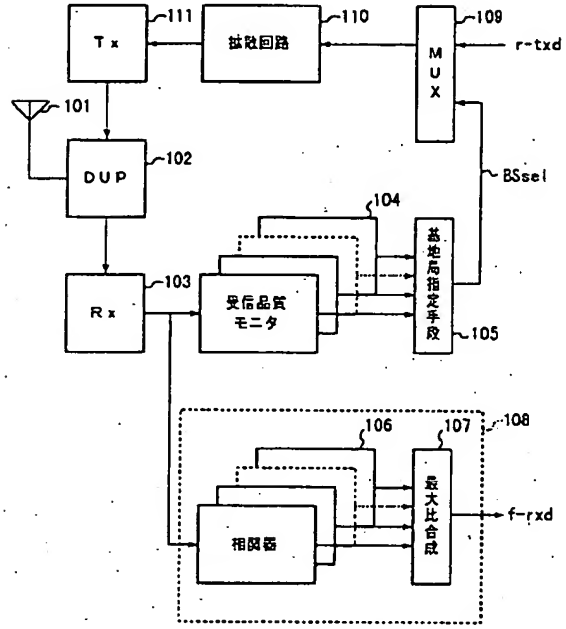
示すブロック図である。

【図６】本発明の第２の実施形態に係る基地局の構成を示すブロック図である。

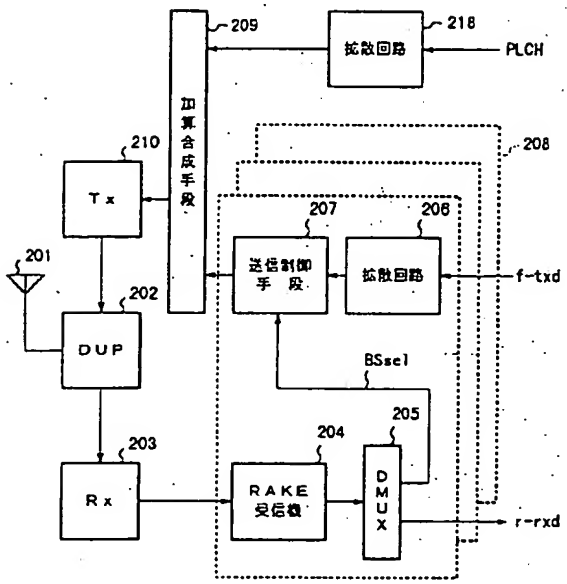
【符号の説明】

１０１、２０１　アンテナ
１０２、２０２　送受共用器
１０３、２０３　無線受信部
１０４　受信品質モニタ手段
１０５　基地局指定手段
１０６　相関器
１０７　最大比合成器
１０８、２０４　ＲＡＫＥ受信機
１０９　マルチプレクサ
１１０、２０６、２１８　拡散回路
１１０、２１０　無線送信部
２０５　デマルチプレクサ
２０７　送信制御手段
２０８　チャネル部
２０９　加算器
３０１、３０２　基地局
３０３　移動機

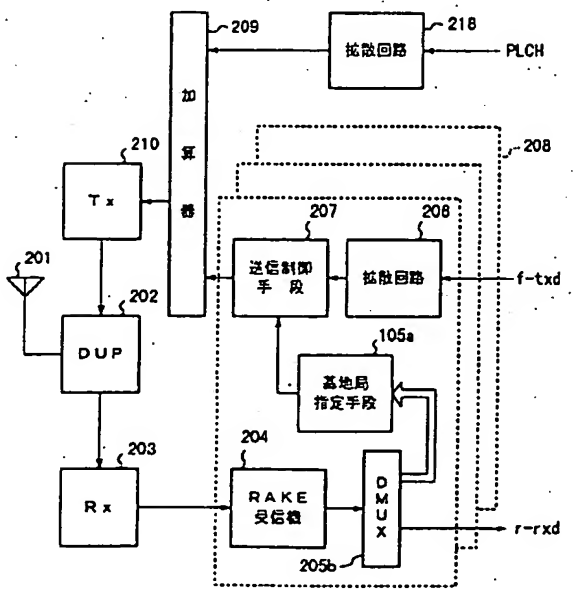
【図１】



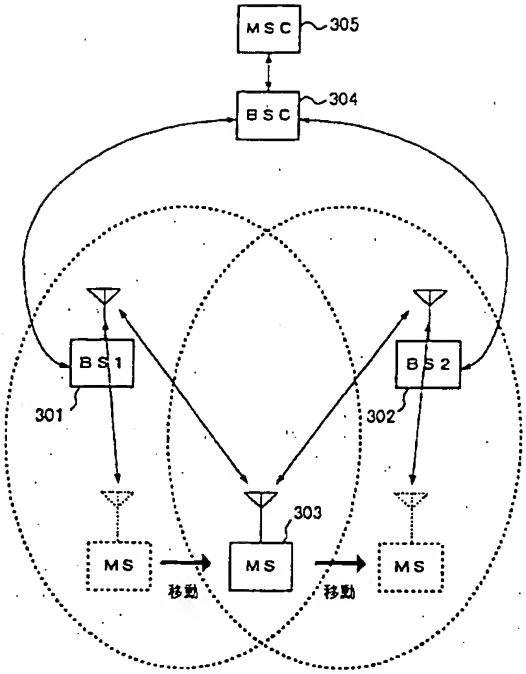
【図２】



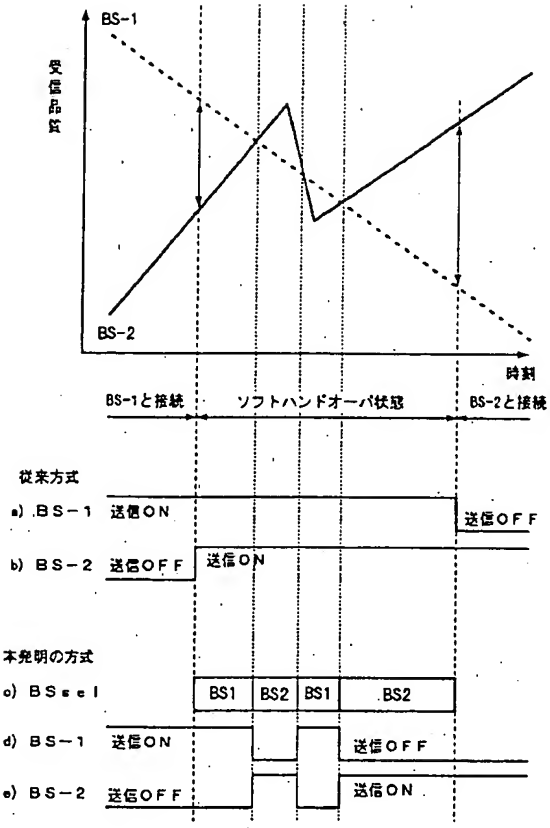
【図６】



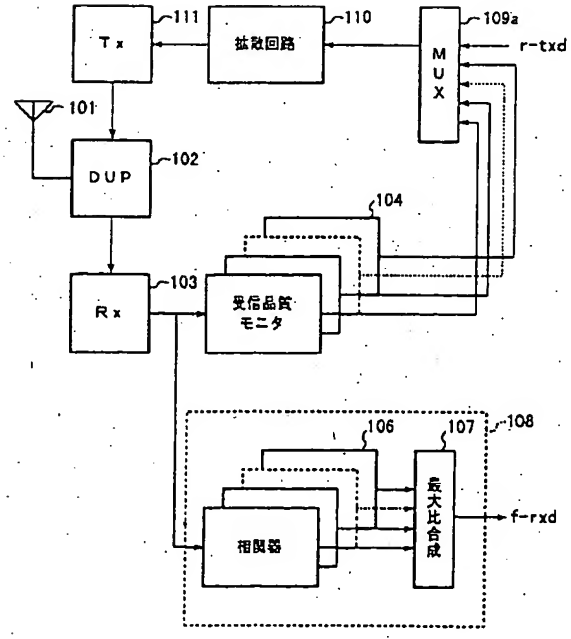
【図３】


MSC
305
BSC
304
BS1
BS2
301
302
303
MS
MS
MS
移動
移動

【図４】


BS-1
受信品質
BS-2
時刻
BS-1と接続
ソフトハンドオーバ状態
BS-2と接続
従来方式
a) BS－1 送信ON
送信OFF
b) BS－2 送信OFF
送信ON
本発明の方式
c) BSsel
BS1
BS2
BS1
BS2
d) BS－1 送信ON
送信OFF
e) BS－2 送信OFF
送信ON

【図５】


Tx
111
拡散回路
110
MUX
109a
r-txd
101
DUP
102
104
Rx
103
受信品質
モニタ
106
107
108
最大比合成
相関器
f-rxd

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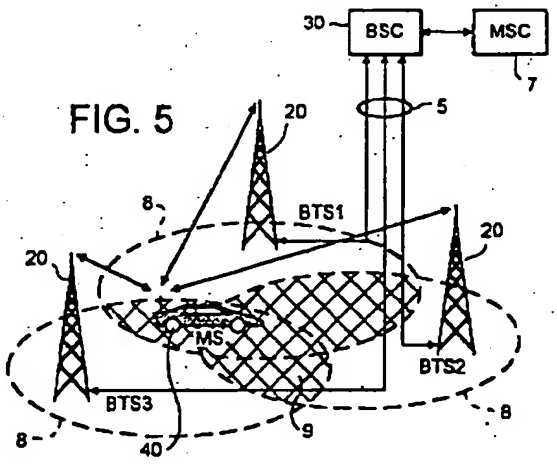
(54) Abstract Title
Soft handoff in cellular communications networks

(57) A cellular mobile communications network includes a mobile station (40), a plurality of base transceiver stations (20), each for receiving uplink signals from the mobile station (40), and a base station controller (30) connected to the said base transceiver stations (20) for receiving therefrom such uplink signals. During a soft hand-off operation involving more than one of the said base transceiver stations (20) of the network, the mobile station (40) includes, in one or more such uplink signals transmitted thereby, respective signal measures for all of the base transceiver stations (20) involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station (40) and the base transceiver station (20) concerned. At least one of the base transceiver stations (20) includes soft hand-off control circuitry operable, when that station is involved in such a soft hand-off operation, to determine, based on an assessment of the signal measure(s) for one or more of the other base transceiver stations (20) involved in the soft hand-off operation, not to forward to the base station controller (30) such an uplink signal received from the mobile station (40).

The load on the fixed network (5) of such a cellular mobile communications network can therefore be reduced.

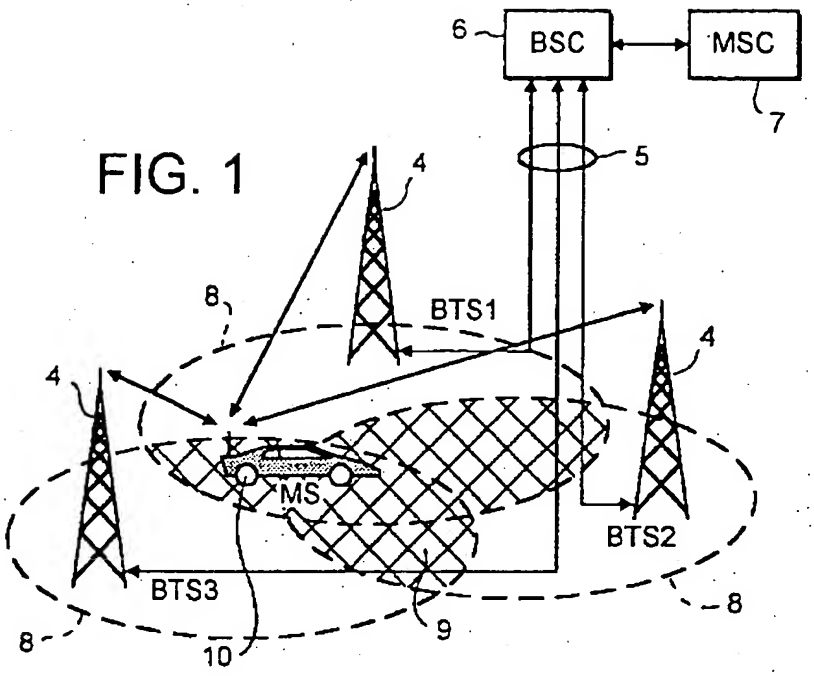
FIG. 5



GB 2 337 414 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1


6
BSC
MSC
7
5
4
8
BTS1
4
4
MS
BTS2
BTS3
8
8
9
10

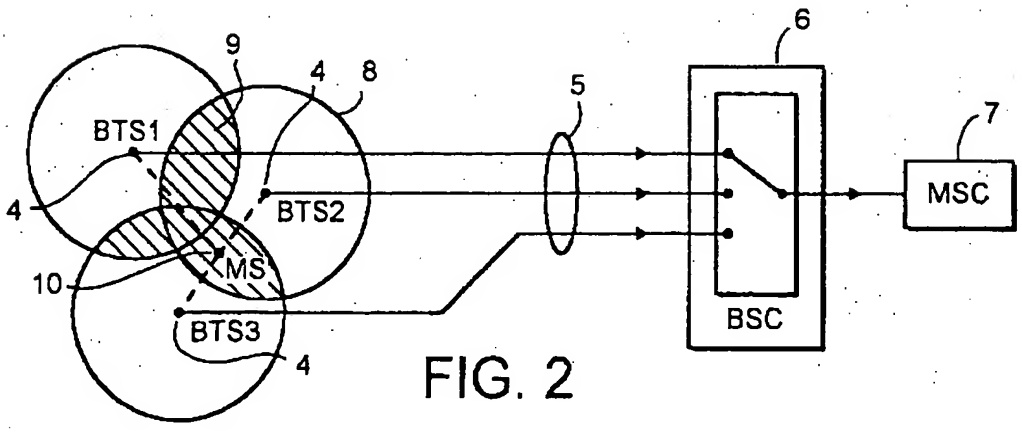

9
4
8
5
6
BTS1
7
MSC
4
BTS2
10
MS
BTS3
4
BSC

FIG. 2

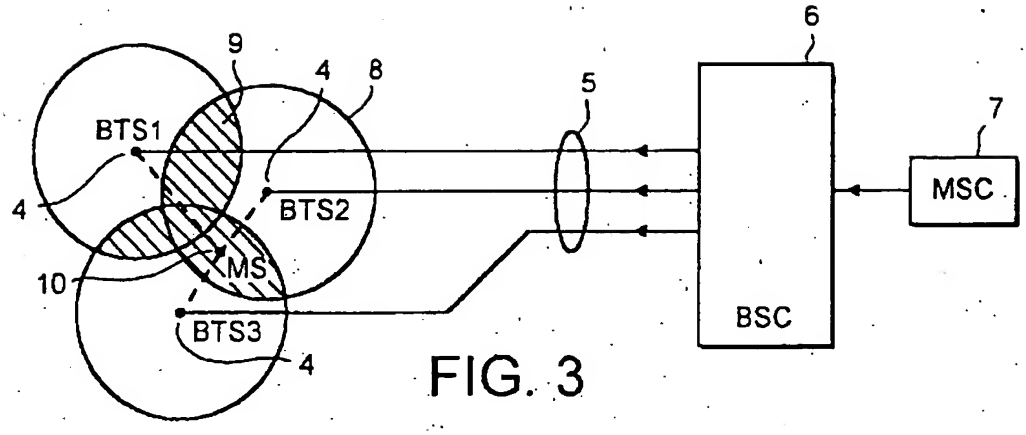

9
4
8
6
5
7
BTS1
4
BTS2
MSC
10
MS
BSC
BTS3
4

FIG. 3

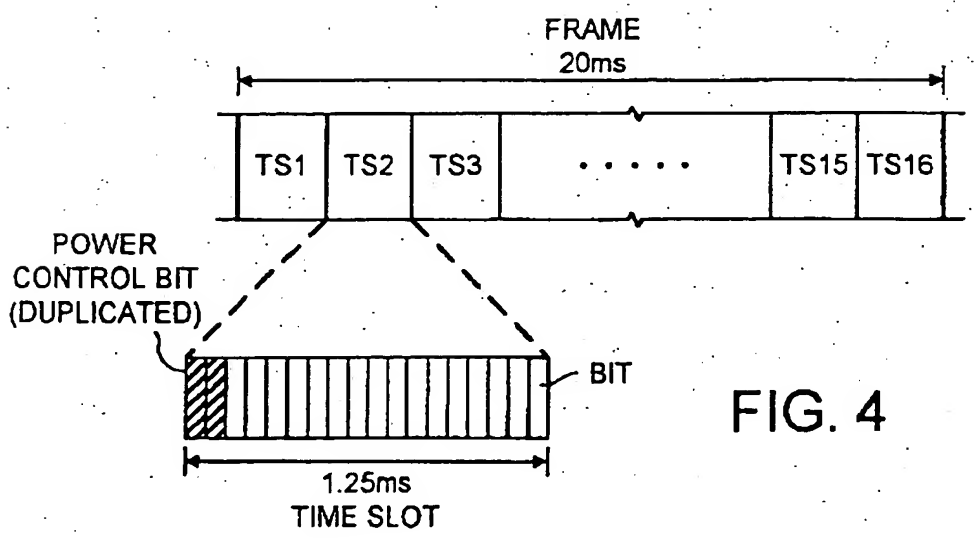
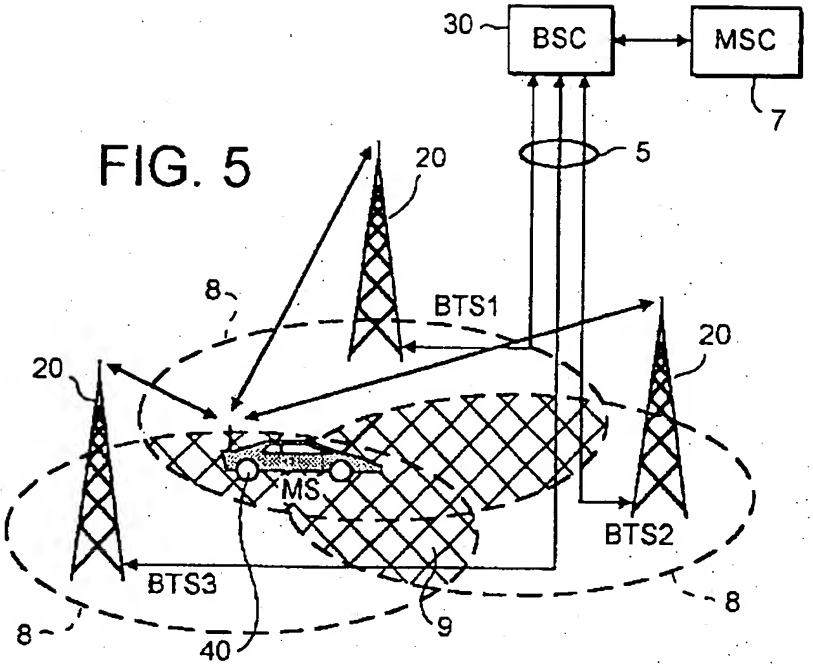

FRAME
20ms
TS1
TS2
TS3
TS15
TS16
POWER
CONTROL BIT
(DUPLICATED)
BIT
1.25ms
TIME SLOT

FIG. 4

FIG. 5


30
BSC
MSC
7
5
20
8
BTS1
20
20
MS
BTS2
BTS3
8
8
40
9

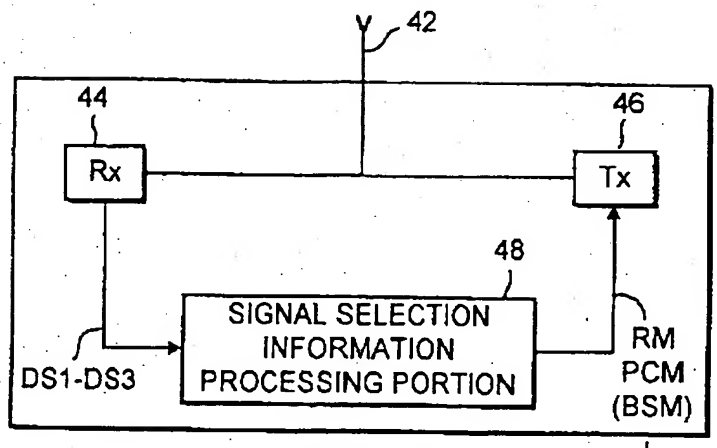

42
44
46
Rx
Tx
48
SIGNAL SELECTION
INFORMATION
PROCESSING PORTION
DS1-DS3
RM
PCM
(BSM)
40

FIG. 6

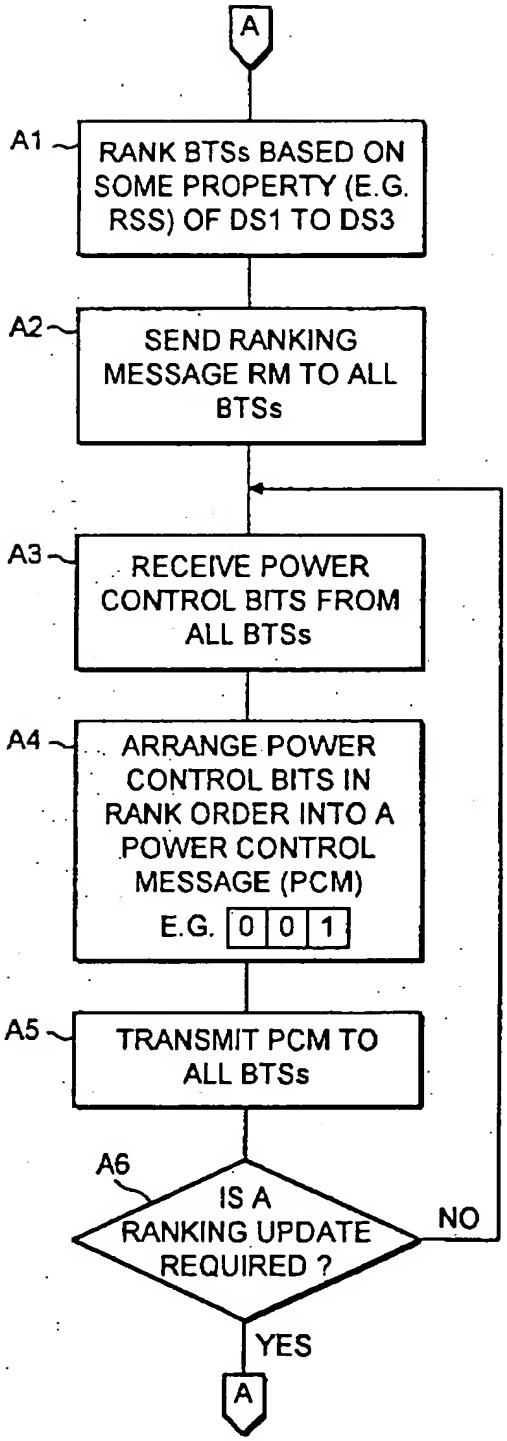

A
A1
RANK BTSs BASED ON SOME PROPERTY (E.G. RSS) OF DS1 TO DS3
A2
SEND RANKING MESSAGE RM TO ALL BTSs
A3
RECEIVE POWER CONTROL BITS FROM ALL BTSs
A4
ARRANGE POWER CONTROL BITS IN RANK ORDER INTO A POWER CONTROL MESSAGE (PCM)
E.G. 0 0 1
A5
TRANSMIT PCM TO ALL BTSs
A6
IS A RANKING UPDATE REQUIRED ?
NO
YES
A

FIG. 7

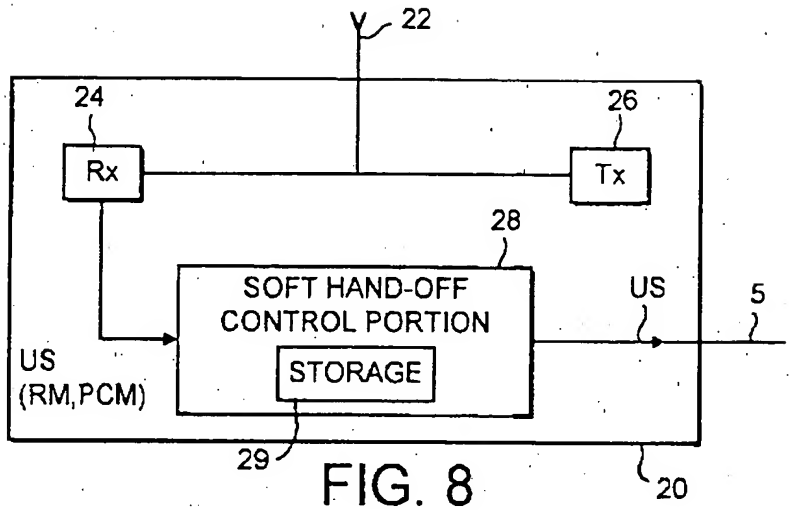


FIG. 8

CASE \ RANK	POWER CONTROL BITS ARRANGED IN A PCM ① BTS3	② BTS1	③ BTS2	DECISION FOR BTS1
1	0	0	1	DO NOT TRANSMIT TO BSC
2	0	1	0	TRANSMIT TO BSC
3a	1	1	0	DO NOT TRANSMIT TO BSC
3b	0	1	1	TRANSMIT TO BSC
4	0	0	0	TRANSMIT TO BSC

FIG. 10

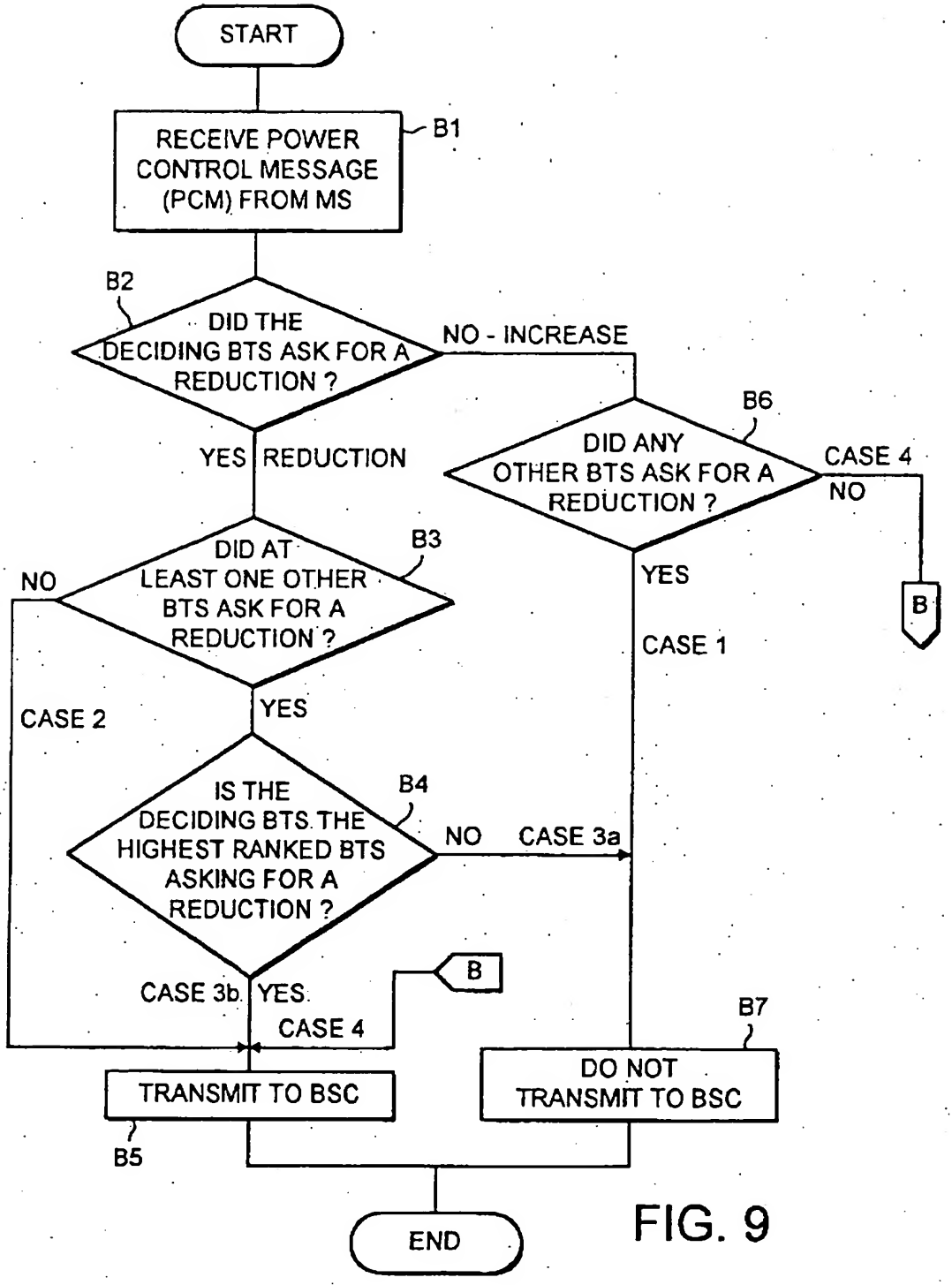

START
RECEIVE POWER CONTROL MESSAGE (PCM) FROM MS
B1
B2
DID THE DECIDING BTS ASK FOR A REDUCTION ?
NO - INCREASE
YES REDUCTION
B6
DID ANY OTHER BTS ASK FOR A REDUCTION ?
CASE 4
NO
B
YES
CASE 1
B3
DID AT LEAST ONE OTHER BTS ASK FOR A REDUCTION ?
NO
CASE 2
YES
B4
IS THE DECIDING BTS THE HIGHEST RANKED BTS ASKING FOR A REDUCTION ?
NO
CASE 3a
CASE 3b
YES
B
CASE 4
B7
DO NOT TRANSMIT TO BSC
TRANSMIT TO BSC
B5
END

FIG. 9

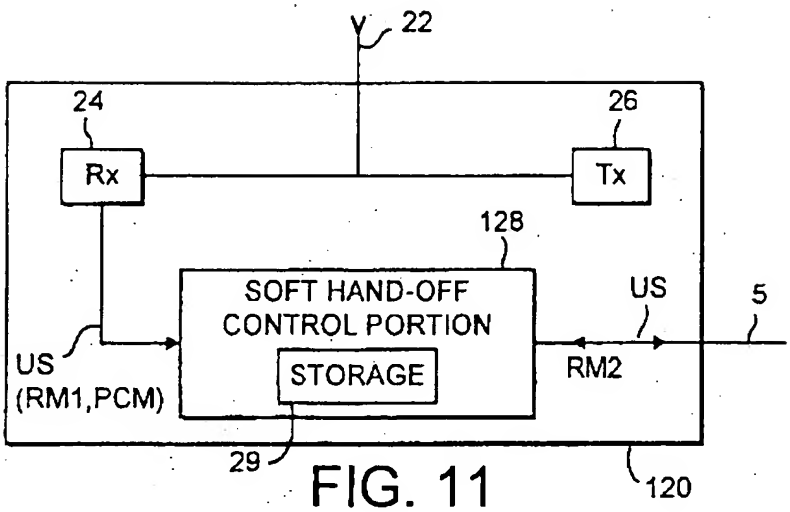


FIG. 11

BTS	AIR-INTERFACE RANK (RM1)	BACKHAUL RANK (RM2)	POWER CONTROL BITS	DECISION
BTS1	1	4	0	DO NOT TRANSMIT TO BSC
BTS2	3	2	1	TRANSMIT TO BSC
BTS3	2	3	1	DO NOT TRANSMIT TO BSC
BTS4	4	1	0	DO NOT TRANSMIT TO BSC

FIG. 12

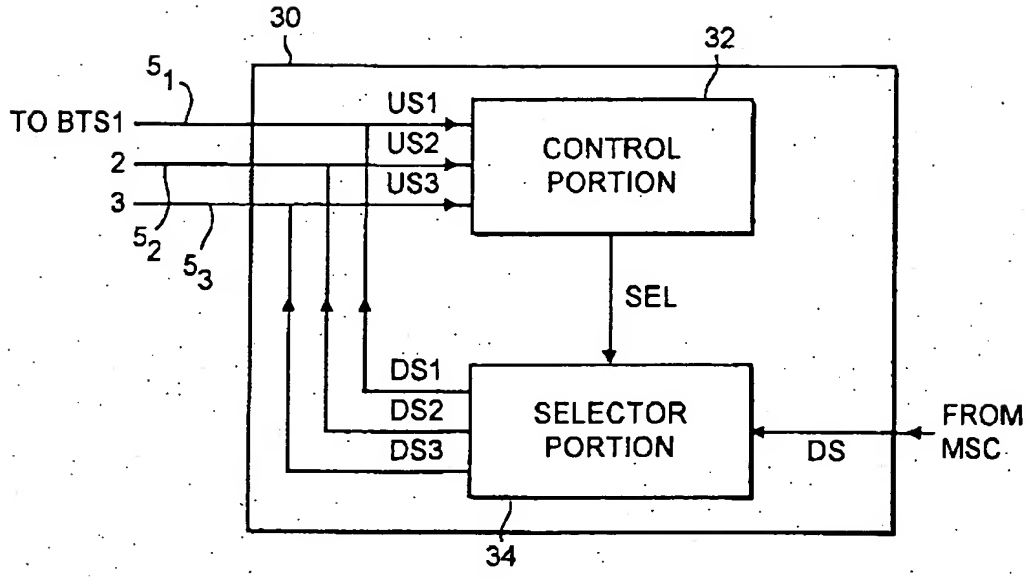

30
32
5_1
TO BTS1
2
3
5_2
5_3
US1
US2
US3
CONTROL PORTION
SEL
DS1
DS2
DS3
SELECTOR PORTION
DS
FROM MSC
34

FIG. 13

SOFT HAND-OFF IN CELLULAR MOBILE COMMUNICATIONS NETWORKS

The present invention relates to cellular mobile communication networks, for example Code Division Multiple Access (CDMA) cellular networks.

Figure 1 of the accompanying drawings shows parts of a cellular mobile telecommunication network according to the Telecommunication Industries Association (TIA)/Electronic Industries Association (EIA) Standard TIA/EIA/IS-95 of October 1994 (hereinafter "IS95"). Each of three base transceiver stations (BTSs) 4 (BTS1, BTS2 and BTS3) is connected via a fixed network 5 to a base station controller (BSC) 6, which is in turn connected to a mobile switching centre (MSC) 7. The BSC 6 serves to manage the radio resources of its connected BTSs 4, for example by performing hand-off and allocating radio channels. The MSC 7 serves to provide switching functions and coordinates location registration and call delivery.

Each BTS 4 serves a cell 8. When a mobile station (MS) 10 is in a so-called "soft hand-off" (SHO) region 9 where two or more cells overlap, a mobile station can receive transmission signals (downlink signals) of comparable strength and quality from the respective BTSs of the overlapping cells. Transmission signals (uplink signals) produced by the mobile station (MS) can also be received at comparable strengths and qualities by these different BTSs when the mobile station is in the SHO region 9.

Figure 2 of the accompanying drawings shows a situation where the MS 10 is located within the SHO region 9, and is transmitting such uplink signals that are being received by plural BTSs 4. According to the IS95 standard, a BTS 4 that receives such an uplink signal from the MS 10 relays the signal to the BSC 6 via a dedicated connection line of the fixed network 5.

At the BSC 6, one of the relayed signals is selected based on a comparison of the quality of each of the received signals, and the selected signal is relayed to the MSC 7. This selection is referred to as Selection Diversity.

Similarly, Figure 3 of the accompanying drawings shows a situation where the MS 10 is located within the SHO region 9 and is receiving downlink signals from plural BTSs 4. According to the IS95 standard, downlink signals received by the BSC 6 from the MSC 7 are relayed to all BTSs 4 involved in the soft hand-off via respective connection lines of the fixed network 5, and subsequently transmitted by all the BTSs 4 to the MS 10. At the MS 10 the multiple signals may be combined, for example, by using maximum ratio combination (MRC), or one of them may be selected based on the signal strength or quality, i.e. using Selection Diversity as for the uplink case.

In contrast to, for example, Global System for Mobile Communication (GSM) networks, in CDMA networks each BTS 4 transmits at the same frequency. Consequently, careful control of transmission power must be maintained to minimise interference problems.

Signals are transmitted as a succession of frames according to the IS95 standard. As Figure 4 of the accompanying drawings shows, each frame is of duration 20 ms, and comprises sixteen 1.25 ms time slots. In each time slot several bits of user data and/or control information can be transmitted.

Power control of transmissions from the MS 10 to the BTSs 4 (uplink power control) in IS95 is achieved as follows. When a BTS 4 receives a signal from the MS 10 it determines whether a predetermined property of the received signal (for example absolute signal level, signal to noise ratio (SNR), signal-to-interference ratio (SIR), bit error rate (BER) or frame error rate

(FER)) exceeds a preselected threshold level. Based on this determination, the BTS 4 instructs the MS 10 either to reduce or to increase its transmission power in the next time slot.

For this purpose, two bits in every time slot of a pilot channel (PCH) from the BTS 4 to the MS 10 are allocated for uplink power control (see Figure 4). Both bits have the same value, and accordingly will be referred to hereinafter as the "power control bit" (or PCB) in the singular. The power control bit is assigned a value of zero by the BTS 4 if the MS 10 is required to increase transmission power by 1 dB, and a value of one if the MS 10 is required to decrease transmission power by 1 dB. The BTS 4 is not able to request directly that the MS 10 maintain the same transmission power; only by alternately transmitting ones and zeros in the power control bit is the transmission power maintained at the same level.

When the MS 10 is in a SHO region 9, the MS 10 is required to make a decision on whether to increase or to decrease uplink transmission power based on a plurality of power control bits received respectively from the BTSs 4 involved in the soft hand-off. Consequently, an OR function is performed on all the power control bits. If the result of this OR function is zero then the MS 10 will increase power on uplink transmissions, and if the result is one then the MS 10 will decrease power on uplink transmissions. In this way, uplink transmission power is only increased if all BTSs 4 ask for an increase.

Power control of transmissions from the BTS 4 to the MS 10 (downlink power control) in IS95 is achieved as follows. When the MS 10 receives a downlink signal from a BTS 4 (or from each of a plurality of BTSs 4 in soft hand-off operation) via a traffic channel (TCH), the FER of that signal is calculated by the MS 10 which

reflects the degree to which the traffic-channel signal has been corrupted by, for example, noise. This FER is then relayed by the MS 10 to the BTS 4 which transmitted the downlink signal concerned, and the BTS 4 uses this FER to decide whether to make any change to its downlink transmission power..

The soft hand-off system described above is effective in improving signal transmission between the MS 10 and the network when the MS 10 is located in regions of cell overlap near the boundaries of the individual cells. Signal quality in these regions when using a single BTS 4 may be relatively poor, but by making use of more than one BTS 4 the quality may be substantially improved.

However, the IS95 soft hand-off system has the disadvantage of increasing signal traffic ("backhaul") in the fixed network 5 since it is necessary to transmit signals carrying the same data and/or control information between the BSC 6 and every BTS 4 involved in the soft hand-off for both the uplink and downlink cases described above. This duplication of information is undesirable for two main reasons. Firstly, it leads to more traffic congestion in the fixed network. Secondly, higher costs are experienced by the mobile service provider (and consequently the mobile service user), who may not own the fixed network infrastructure.

Therefore it is desirable to provide an improved soft hand-off method capable of affording the usual benefits of soft hand-off whilst at the same time reducing the load on the fixed network.

According to a first aspect of the present invention there is provided a cellular mobile communications network including: a mobile station; a plurality of base transceiver stations, each for receiving uplink signals from the mobile station; and

base station controller means connected to the said base transceiver stations for receiving therefrom such uplink signals; wherein the said mobile station is operable, during a soft hand-off operation involving more than one of the said base transceiver stations of the network, to include, in one or more such uplink signals transmitted thereby, respective signal measures for all of the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and at least one of the said base transceiver stations includes soft hand-off control means operable, when that station is involved in such a soft hand-off operation, to determine, based on an assessment of the signal measure(s) for one or more of the other base transceiver stations involved in the soft hand-off operation, not to forward to the said base station controller means such an uplink signal received from the mobile station.

According to a second aspect of the present invention there is provided a mobile station, for use in a cellular mobile communications network, including: transmitter means for transmitting uplink signals to a base transceiver station of the network; and signal information processing means connected to the said transmitter means and operable, during a soft hand-off operation involving a plurality of such base transceiver stations of the network, to cause the said transmitter means to include, in one or more of the said uplink signals, respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned.

According to a third aspect of the present invention there is provided a base transceiver station, for use in a cellular mobile communications network, including: receiver means for receiving uplink signals from a mobile station of the network, one or more of which uplink signals includes, when the mobile station is engaged in a soft hand-off operation involving the claimed base transceiver station and at least one further base transceiver station of the network, respective signal measures for all the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and soft hand-off control means operable, when the claimed base transceiver station is involved in such a soft hand-off operation, to determine, based on an assessment of the signal measure(s) for one or more of the other base transceiver stations involved in the operation, not to forward to base station controller means of the network such an uplink signal received from the mobile station.

According to a fourth aspect of the present invention there is provided a soft hand-off control method for use in a cellular mobile communications network, wherein: when a soft hand-off operation involving more than one base transceiver station of the network is being performed, a mobile station of the network includes, in one or more uplink signals transmitted thereby, respective signal measures for all the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and in at least one of the involved base transceiver stations, the signal measure(s) of one or more of the other base transceiver stations involved in

the operation is/are assessed and a determination is made, based on the assessment, whether or not to forward to a base station controller of the network an uplink signal received from the mobile station.

According to a fifth aspect of the present invention there is provided a cellular mobile communications network including: a mobile station; a plurality of base transceiver stations, each for transmitting downlink signals to the said mobile station and for receiving uplink signals from the said mobile station; and base station controller means connected to the said base transceiver stations for applying thereto such downlink signals; wherein the said mobile station is operable, during a soft hand-off operation involving more than one of the said base transceiver stations of the network, to produce respective signal measures for all the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and the network including base transceiver station selection means operable to employ the produced signal measures to determine which of the base transceiver stations involved in the operation should be used to transmit a subsequent one of the said downlink signals to the mobile station, and to cause that subsequent downlink signal to be transmitted by the base station controller means only to the said determined base transceiver station(s).

According to a sixth aspect of the present invention there is provided a mobile station, for use in a cellular mobile communications network, including: transmitter means for transmitting uplink signals to a base transceiver station of the network; and signal information processing means connected to the

said transmitter means and operable, during a soft hand-off operation involving a plurality of such base transceiver stations of the network, to produce respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned, and also operable to employ the produced signal measures to determine which of the involved base transceiver stations should be used to transmit a subsequent downlink signal to the mobile station, and to cause the said transmitter means to include, in such an uplink signal transmitted thereby, a base transceiver station selection message identifying the determined base transceiver station(s).

According to a seventh aspect of the present invention there is provided a base station controller, for use in a cellular mobile communications network to apply downlink signals to a plurality of base transceiver stations of the network, including: receiver means for receiving uplink signals from one or more of the base transceiver stations, at least one of which uplink signals includes, when a mobile station is engaged in a soft hand-off operation involving more than one of the base transceiver stations of the network, a base transceiver station selection message identifying which of the involved base transceiver stations should be used to transmit a subsequent one of the said downlink signals to the mobile station; and soft hand-off control means operable to receive the said uplink signal including the base transceiver station selection message and to transmit the said subsequent downlink signal only to the said determined base transceiver station(s) identified in the message.

According to an eighth aspect of the present

invention there is provided a soft hand-off control method for use in a cellular mobile communications network, wherein: when a soft hand-off operation involving more than one base transceiver station of the network is being performed, a mobile station produces respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and the produced signal measures are employed to determine which of the involved base transceiver stations should be used to transmit a subsequent downlink signal to the mobile station, and the said subsequent downlink signal is transmitted by base station controller means of the network only to the said determined base transceiver station(s).

The signal measures can be any suitable measure of the communications-channel performance between the mobile station and the base transceiver stations, for example signal strength measures (received signal strength in terms of power or amplitude or quality measures (frame error rate, signal-to-interference ratio, etc), or a combination of both strength and quality.

In preferred embodiments of the first to fourth aspects of the present invention the signal measures are respective power control bits received by the mobile station from the base transceiver stations involved in the soft hand-off operation. These power control bits indicate whether or not the mobile station is to increase or decrease its uplink transmission power to the base transceiver station and therefore serve conveniently as measures of the uplink channel performance channel between the mobile station and each base transceiver station.

Reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1, discussed hereinbefore, shows parts of a cellular mobile telecommunication network according to IS95;

Figure 2, also discussed hereinbefore, shows a schematic view for use in explaining processing of uplink signals in a soft hand-off operation performed by the Figure 1 network;

Figure 3, also discussed hereinbefore, shows a schematic view for use in explaining processing of downlink signals in such a soft hand-off operation;

Figure 4, also discussed hereinbefore, illustrates the format of a time frame in the Figure 1 network;

Figure 5 shows parts of a mobile telecommunication network embodying the present invention;

Figure 6 shows parts of a mobile station embodying to the present invention;

Figure 7 is a flowchart for illustrating uplink processing operations in the Figure 6 mobile station;

Figure 8 shows parts of a base transceiver station embodying the present invention;

Figure 9 is a flowchart for illustrating uplink processing in the Figure 8 base transceiver station;

Figure 10 shows an example decision table employed in the uplink processing by the Figure 8 base transceiver station; and

Figure 11 shows parts of another base transceiver embodying the present invention;

Figure 12 shows a further example decision table employed in the uplink processing by the Figure 10 base transceiver station;

Figure 13 shows parts of a base station controller embodying the present invention.

Figure 5 shows parts of a mobile telecommunication network embodying the present invention. In Figure 5,

elements that are the same as elements of the Figure 1 network described previously have the same reference numerals and an explanation thereof is omitted.

The Figure 5 network is a wideband CDMA (W-CDMA) network for a proposed new standard for mobile telecommunications, referred to as a universal mobile telecommunications system (UMTS) or UMTS terrestrial radio access (UTRA). This is generally similar to the IS95-standard network described previously, although certain implementation details are yet to be finalised. Details that are different from IS95 include the frame duration, which is 10ms, and the time-slot duration which is 625μs. The overall bit rate is within the range from 8kbits/s to 2Mbits/s. Also downlink power control in W-CDMA is closed-loop and is based on the same principles as the uplink power control.

In Figure 5, each of three base transceiver stations (BTSs) 20 (BTS1, BTS2 and BTS3) is connected via a fixed network 5 to a base station controller (BSC) 30, which is in turn connected to a mobile switching centre (MSC) 7. Each BTS 20 serves a cell 8. A mobile station (MS) 40 is in a soft hand-off (SHO) region 9 and can receive downlink signals from, and transmit uplink signals to, all the BTSs 20 involved in the soft hand-off.

The Figure 5 network corresponds generally with the Figure 1 network, but the MS 40, BTSs 20 and BSC 30 are constructed and operate differently from the corresponding elements in Figure 1.

Figure 6 is a block diagram showing parts of a MS 40 embodying the present invention. An antenna element 42 is connected (e.g. via a duplexer - not shown) to a receiver portion 44 and a transmitter portion 46. A signal selection information processing portion 48 from the receiver portion 44 respective downlink signals DS1 to DS3 produced by the three BTSs BTS1 to BTS3 involved

in the soft hand-off operation. The signal selection information processing portion 48 applies a ranking message RM and a power control message PCM to the transmitter portion 46.

Figure 7 is a flow chart showing the actions performed by the signal selection processing portion 48 of the MS 40 when performing uplink processing whilst the MS is in the soft hand-off region 9. Firstly, in step A1, the three BTSs 20 are ranked based on a predetermined property of the respective downlink signals DS1 to DS3 that are being received by the MS 40, for example received signal strength (RSS). Alternatively, the ranking may be based on a "first-come first-served" basis, i.e. on the order in which BTSs 20 became involved in the soft hand-off operation. Alternatively, the ranking could be random. In step A2 a ranking message RM, indicating the order in which the BTSs are presently ranked, is then sent via a control channel to all BTSs 20. After the ranking message is sent, processing continues to step A3.

The loop from steps A3 to A6 occurs once for every time slot of the traffic channel (TCH) and its associated control channel (DCCH) in the downlink direction. As was the case for the IS95 uplink power control method described above, every time slot of the TCH/DCCH from BTS 20 to MS 40 contains a power control bit for the purpose of instructing the MS 40 to increase or reduce its uplink transmission power. In step A3, such a power control bit is received from each of the three BTSs 40 involved in the soft hand-off.

In step A4, the plurality of power control bits received in step A3 are arranged into a power control message (PCM) in rank order according to the current BTS ranking decided in step A1. Following this, in step A5, the PCM is transmitted to all involved BTSs via a control channel.

The ranking decided in step A1 may periodically require updating, for several reasons. Firstly, as the MS 40 moves, a downlink signal may be received from a new BTS or an existing BTS may no longer be able to provide a detectable downlink signal. Secondly, the qualities of the signals received from the BTSs 20 may have changed, e.g. due to fading. Therefore, in step A6 it is decided whether or not a ranking update is required. Such an update may be carried out periodically at regular time intervals (for example every several hundred milliseconds as in GSM networks), or every frame or even every time slot. Alternatively, the ranking could be updated only when a new BTS is detected or contact with an existing one lost. If an update is required, processing is returned to step A1, otherwise processing returns to step A3 for the start of the next time slot.

Figure 8 is a block diagram showing parts of a BTS 20 embodying the present invention. This BTS 20 is specially adapted to receive and process the ranking message RM sent by the MS 40 in step A2 of Figure 7 and the power control message PCM sent by the MS 40 in step A5.

An antenna element 22 is connected (e.g. via a duplexer - not shown) to a receiver portion 24 and a transmitter portion 26. A soft hand-off control portion 28 receives an uplink signal US from the receiver portion 24, and in turn applies the received US (or a signal derived therefrom) to the fixed network 5 for transmission to the BSC 30. Optionally contained within the soft hand-off control portion 28 is a storage portion 29.

In use of the BTS 20, the uplink signals sent by the MS 40 when it is in the soft hand-off region 9 include, from time to time, a ranking message RM. The uplink signals US detected by the receiver portion 24

in the BTS 20 are applied to the soft hand-off control portion 28. When the soft hand-off control portion 28 detects that a ranking message RM is included in one of the uplink signals US received thereby, it processes the ranking message concerned to determine the rank of its BTS within the ranking order determined by the MS in step A1 described above.

In each time slot, the uplink signals US produced by the receiver portion 24 also include a power control message PCM determined by the MS 40 as described above in step A4 of Figure 7.

Operation of the soft hand-off control portion 28 in response to the presence of such a PCM in the uplink signal US produced by the receiver portion 24 will now be described with reference to Figure 9.

It is assumed that, by the time the sequence shown in Figure 9 is commenced, a ranking message RM has already been received and processed (as indicated above) by the soft hand-off control portion 28.

In Figure 9, in step B1 the PCM is received by the soft hand-off control portion and examined.

In step B2, the soft hand-off control portion 28 determines whether its BTS 20 specified, in its last power control bit (PCB) sent to the subject MS 40, that the MS 40 should reduce its uplink transmission power (PCB=1). If so, processing proceeds to step B3.

In step B3, the soft hand-off control portion 28 goes on to examine the PCM which includes the respective last PCBs of all of the other BTSs involved in the present soft hand-off operation. If any of those PCBs is 1, this denotes that at least one other BTS requested the subject MS 40 to reduce its uplink transmission power. In this case, processing proceeds to step B4.

In step B4, the soft hand-off control portion 28 determines whether or not, in the order of ranking

presently determined by the MS 40, its BTS is ranked higher than each other BTS that requested the MS to reduce its uplink transmission power.

If its BTS is the highest-ranked BTS that has requested a power reduction, processing proceeds to step B5 in which the soft hand-off control portion 28 determines that its BTS is required to send the uplink signal US received in the current time slot to the BSC 30 via the fixed network 5.

If in step B4 the soft hand-off control portion 28 determined that another BTS, having a higher rank than its BTS, also asked for a power reduction, processing proceeds to step B7 in which the soft hand-off control portion 28 determines that it is not required to transmit the uplink signal US received from the mobile station 40 in the current time slot to the BSC 30.

In step B3, if the soft hand-off control portion 28 determines that its BTS was the only BTS involved in the soft hand-off operation to ask for a power reduction, processing proceeds to step B5 in which the uplink signal US for the current time slot is transmitted by the BTS to the BSC 30.

If in step B2 the soft hand-off control portion 28 determines that it asked the MS 40 for a power increase (i.e. its last PCB was 0), processing proceeds to step B6. In step B6 the soft hand-off control portion 28 determines, by referring to the PCM, whether any other BTS asked for a reduction (i.e. the last PCB specified by that other BTS was 1). If so, the soft hand-off control portion 28 determines that its BTS is not required to transmit the uplink signal US to the BSC 30 in the current time slot and processing proceeds to B7. If, on the other hand, no other BTS requested a power reduction (i.e. all BTSs involved in the present soft hand-off operation requested an increase in the MS uplink transmission power), processing proceeds to step

B5 and the US for the current time slot is transmitted by the BTS to the BSC 30.

After step B5 or B7 (as the case may be) processing for the current time slot is completed and the soft hand-off control portion 28 awaits the next PCM or RM from the MS 40.

As described above with reference to Figure 9, by virtue of its receipt of the PCM, the soft hand-off control portion 28 in each BTS involved in a soft hand-off operation has knowledge of the last power control bit sent to the subject MS 40 by all of the other BTSs, as well as by its own BTS. By comparing these PCBs, the soft hand-off control portion in each BTS can decide whether or not to transfer the uplink signal US received in the current time slot to the BSC, such that, whenever possible, only one of the BTSs involved in the soft hand-off transfers the uplink signal US to the BSC.

Based on the received PCBs, the soft hand-off control portion 28 in each "deciding BTS" identifies whether the power reduction/increase requests by the different BTSs fall into one of four different cases.

Case 1: If the deciding BTS has asked for a power increase whilst at least one other BTS has asked for a power reduction, it suggests that at least one other BTS is enjoying a better-quality uplink signal from the MS 40. Accordingly, this other BTS, rather than the deciding BTS, should send the uplink signal US in the current time slot to the BSC. The deciding BTS therefore decides not to send the uplink signal US.

Case 2: If the deciding BTS has requested a power reduction but every other BTS involved in the soft hand-off operation has requested an increase in power, the deciding BTS determines that it is receiving the best-quality signal from the MS and decides to transmit the US in the current time slot to the BSC.

Case 3: If the deciding BTS has asked the MS to reduce power, and at least one other BTS has also asked for such a power reduction, the decision as to which BTS is to transfer the US is based on rank. For example, the highest-ranked of the BTSs requesting a power reduction determines that it should transfer the US in the current time slot to the BSC. Thus, case 3 is divided into two sub-cases 3a and 3b. In case 3a the deciding BTS determines that a higher-ranked BTS has asked for a power reduction and so determines that it should not send the US. In case 3b, on the other hand, the deciding BTS determines that it is the highest-ranked of the BTSs requesting a power reduction, and transfers the US to the BSC 30.

Case 4: If all the BTSs involved in the soft hand-off operation have requested the MS to increase its transmission power, all of the BTSs transfer their respective uplink signals US in the current time slot to the BSC, as in the conventional soft hand-off operation described previously with reference to Figure 2. This permits maximum ratio combining (MRC) processing of the different uplink signals at the BSC 30.

As described above, the ability to make decisions at the BTS, rather than at the BSC, facilitates a significant reduction in the fixed-network backhaul for uplink processing in the soft hand-off operation.

Figure 10 shows an example decision table for use in illustrating operation of the soft hand-off control portion 28 during uplink processing. In this example, it is assumed that the BTSs involved in the soft hand-off operation are ranked as follows: BTS3 has rank ① (the highest rank); BTS1 has rank ②; and BTS2 has rank ③ (the lowest rank).

As illustrated in Figure 10, the MS 40 arranges the power control bits PCBs for the different BTSs in

the power control message PCM in the order of rank of the BTSs. Thus, the first bit in the PCM corresponds to the rank-① BTS (BTS3 in this example); the second bit in the PCM corresponds to the rank-② BTS (BTS1); and the third bit in the PCM corresponds to the rank-③ BTS (BTS2).

In this example, it is also assumed that the deciding BTS is BTS1 (which in this case is the middle-rank BTS).

In case 1 above, the PCM = 001, indicating that BTS2 alone has requested a power reduction. Thus, BTS2 should transmit the uplink signal for the current time slot and BTS1 determines that it should not transmit the uplink signal.

In case 2, the PCM = 010, indicating that the deciding BTS1 alone has requested a power reduction. Accordingly, BTS1 determines that it should transmit the uplink signal US to the BSC.

In case 3a, both BTS3 and BTS1 have requested a power reduction, whereas BTS2 has requested a power increase. In this case, the deciding BTS1 refers to its rank in the order of ranking determined by the MS and establishes that, as the first PCM bit (corresponding to the higher-rank BTS3) is 1, it (the deciding BTS1) should not transmit the US to the BSC.

In case 3b, on the other hand, the PCM = 011, indicating that both BTS1 and BTS2 have requested a power reduction and BTS3 has requested a power increase. In this situation, the deciding BTS1 determines that no BTS of rank higher than it has requested a power reduction (the first PCM bit is 0) and therefore decides to transmit the US to the BSC.

Finally, in case 4, the PCM = 000 which indicates that all BTSs have requested a power increase. In this case, the deciding BTS1 determines that it should transmit the US to the BSC.

It will be appreciated that it is not essential for the decision-making carried out by the BTSs involved in the soft hand-off operation to result in only one of the BTSs transmitting the US to the BSC in the current time slot in the cases 1, 2, 3a and 3b. For example, some benefit would still be achieved, in terms of reducing the fixed-network backhaul for uplink processing, as long as at least one BTS decides not to transmit the US in any of the cases 1, 2, 3a or 3b.

It will also be appreciated that, in order to avoid erroneous decision making in the BTSs, based for example on temporary phenomena in the uplink signal reception at the BTSs, it may be preferable for the BTSs to make their uplink-signal transmission decisions based on a history of the power control bits sent to the MS. For example, the storage portion 29 included within each soft hand-off control portion 28 could be used to store one or more previous PCMs received by the BTS. Using this PCM history, as stored in the storage portion 29, each BTS could make a more informed decision as to whether or not to transmit the uplink signal to the BSC.

For example, if the history of the PCMs shows that each BTS is sending alternate ones and zeros to the MS (indicating generally that the signal conditions between the MS and each BTS involved in the soft hand-off operations are effectively static), it would be unproductive for the transmitting BTS to continuously "swap around" as a result of the alternating ones and zeros. Such swapping around could be eliminated, for example, by providing each soft hand-off control portion 28 with a facility to identify a "don't care" reception situation (such as a stream of alternating ones and zeros) for each BTS involved in the soft hand-off operation. In this "don't care" situation, the soft hand-off control portion 28 could simply decide to

apply the last decision it made as to whether or not to transmit the uplink signal to the BSC this time around, so eliminating the swapping around phenomenon. Other "don't care" situations could also be identified, for example by applying a moving average to the sequence of PCBs received for any given BTS.

Similarly, a moving average could be used to make the decision as to whether the reception conditions fall into any of cases 1 to 4 in Figure 10. In this case, instead of "1" or "0" in Figure 10 representing just the PCB in the current PCM, "1" or "0" could represent the moving average (rounded up or down to 1 or 0) for the BTS concerned over the past (say) 4 PCMs.

It will also be understood that it is not necessary for the uplink processing to take place every time slot. It would also be possible for the PCM to be transmitted only once per frame, in which case the decision-making applied by each BTS would be made on a frame-by-frame basis.

Furthermore, it would even be possible for the decisions to be made at time intervals other than frames or time slots, for example based on a time interval consistent with the fading characteristics of the RF channels in the network.

In the embodiment described above, when two or more BTSs involved in the soft hand-off operation have comparably-good uplink channel performances, the BTS used to transmit the uplink signal to the BSC is selected based on the BTS ranking determined by the mobile station alone. However, it is not essential for the ranking of the BTSs to be performed exclusively by the MS and it is possible for the ranking (or part of it) to be performed elsewhere in the network (e.g. in the BSC) based on other criteria.

For example, in a preferred embodiment the BTSs may be ranked according to a first ranking determined

by the mobile station as described previously. This first ranking may be termed a ranking based on the air interface between the mobile station and the BTSs. The BTSs may also be ranked according to a second ranking determined by the BSC. This second ranking may be based on so-called "backhaul preference", i.e. an order of preference in which the BTSs should transfer (backhaul) the received uplink signal to the BSC. Factors which influence the backhaul preference include: congestion and availability of the fixed-network communication paths linking the different BTSs to the BSC; the quality of those communication paths; and the cost of using those communications paths. In particular, the fixed network employed to provide the communications paths between the BTSs and the BSC is subject to congestion so that availability problems may arise. Also, some communications paths such as microwave links may offer relatively low quality compared to other types of communication path such as fibre-optic paths. Cost considerations also arise because the fixed-network operator may levy different charges for the use of the different communications paths, including different charges for different bandwidths and different tariffs at different times of use.

Accordingly, by ranking the BTSs in accordance with backhaul preference (as well as in accordance with air-interface performance), it is possible to employ a combination of the backhaul preference determined by the second ranking and the air-interface preference determined by the first ranking in suitable cases.

Figure 11 shows parts of a BTS 120 for use in the above-described example. The Figure 11 BTS 120 is constituted in basically the same way as the BTS 20 of Figure 8, but includes a modified soft hand-off control portion 128 which receives a first ranking message RM1

from the mobile station and a second ranking message RM2 from the BSC via the fixed-network connection path 5.

To this end the BSC in this embodiment further includes a communications path ranking portion (not shown in the drawings) which determines the backhaul preference based on one or more of the factors mentioned above and transmits the second ranking message specifying the determined backhaul preference to the BTSs involved in the soft hand-off operation.

The soft hand-off control portion 128 employs a super decision-matrix when deciding whether or not its BTS 120 should forward an uplink signal US received from the mobile station to the BSC.

Figure 12 shows one example of the application of this super decision matrix.

In this example, it is assumed that four BTSs are involved in the soft hand-off operation. In accordance with the first ranking message RM1 provided to the soft hand-off control portion 128 by the mobile station, the four BTSs are ranked as follows: BTS1 - rank ①; BTS2 - rank ③; BTS3 - rank ②; BTS4 - rank ④. According to the second ranking message RM2 provided to the soft hand-off control portion 128 by the BSC, the BTSs are ranked differently as follows: BTS1 - rank ④; BTS2 - rank ②; BTS3 - rank ③; and BTS4 - rank ①.

In this example it is also assumed that the power control bits (arranged in a power control message PCM received from the mobile station) are (in order from BTS1 to BTS4) 0,1,1,0. This signifies that BTS2 and BTS3 are both enjoying comparably-good communications-channel performances. In this case (which corresponds to cases 3a and 3b in Figure 10) a decision, as to which of these two candidate BTSs BTS2 and BTS3 should transmit the received uplink signal in the next time slot to the BSC, is made based on a combination of the

two rankings (air-interface ranking provided by the first ranking message RM1 and backhaul ranking provided by the second ranking message RM2).

In each of the BTSs concerned (BTS2 and BTS3), the soft hand-off control portion 128 determines that it should follow the backhaul ranking preference, which indicates that BTS2 rather than BTS3 should be used to transmit the uplink signal to the BSC, even though according to the air-interface ranking, BTS2 is inferior to BTS3. Such a decision is possible because, in this case, the difference in air-interface ranking between the two candidate BTSs BTS2 and BTS3 is only one, indicating that BTS2 is only slightly inferior to BTS3. (It might not be desirable to follow the backhaul ranking preference had the two candidate BTSs had been BTSs having very different air-interface rankings, for example BTS1 and BTS4).

Thus, as described above, the decision-making in the soft hand-off control portions of the different BTSs involved in the soft hand-off operation can be based on one of the two rankings (air-interface ranking and backhaul ranking) alone or on a combination of both types of ranking. In particular, it will be understood that when the ranking applied by the mobile station (air-interface ranking) is purely random or based on the order of involvement of the BTSs in the soft hand-off operation, it may well be preferable for the air-interface ranking to be overridden completely by the backhaul ranking.

Next, downlink processing in the soft hand-off operation of the Figure 5 network will be described. In such downlink processing, if macro-diversity based on maximum ratio combining (MRC) is required at the MS during the soft hand-off operation, all of the BTSs involved in the soft hand-off operation must transmit the same information to the MS, so that no reduction in

the fixed-network backhaul can be achieved in this case. However, if MRC is not required at the MS in the soft hand-off region, downlink macro-diversity can be based on selection (or switched) diversity at the BSC 30, in accordance with another aspect of the present invention.

Referring again to Figure 6, to deal with the downlink processing, the signal selection information processing portion 48 is required to perform a further function in addition to the generation of the ranking message RM and power control message PCM as described previously. In this case, as in the previously-described ranking process the signal selection information processing portion 48 again processes the respective downlink signals DS1 to DS3 received from the BTSs (BTS1 to BTS3) involved in the soft hand-off operation, and compares these downlink signals according to a predetermined property (which may be the same property as for the uplink processing case or another property, as desired). In a preferred embodiment, the predetermined property is the received signal strength (RSS), possibly together with the signal-to-interference ratio (SIR). These performance measures are determined for the downlink DCCH.

The signal selection information processing portion 48 employs the performance measures to select which of the BTSs involved in the soft hand-off operation is to be used to transmit the downlink signal to the MS in the next time slot.

The signal selection information processing portion 48 may select the BTS that is to transmit the downlink signal in the next time slot based on the following cases.

Case 1: If the RSS (and/or SIR) of a single BTS is higher than each other BTS, that single BTS is selected to transmit the downlink signal in the next

time slot.

Case 2: If two or more BTSs have comparably-good RSS (and/or SIR), one of them is selected based on an order of ranking (e.g. order of involvement in the soft hand-off operation or random).

Case 3: If all the BTSs involved in the soft hand-off operation fail to meet a prescribed RSS (and/or SIR) threshold, all the BTSs are selected to transmit the downlink signal in the next time slot, so that a MRC operation can be performed at the MS 40 to give the best chance of obtaining a useful signal.

After determining which BTS(s) is/are to be used, the signal selection information processing portion 48 transmits a BTS selection message (BSM), identifying the BTS(s) to be used, to all of the BTSs on a control channel.

For example, using two bits to provide the BSM, the BSM may be set to "01" to designate BTS1; "10" to designate BTS2; and "11" to designate BTS3. "00" denotes that all the BTSs should be used to transmit the downlink signal in the next time slot.

Each BTS receives the BSM via the control channel from the MS 40. One or more of the BTSs then forward the BSM to the BSC 30. As described previously with reference to Figures 8 to 10, only one BTS may decide to transmit the uplink signal including the BSM to the BSC, by applying the decision-making strategy described previously for the uplink processing. However, the number of BTSs that forward the BSM to the BSC is irrelevant to this aspect of the invention, and all BTSs could forward the BSM to the BSC.

Figure 13 shows part of a BSC adapted to perform downlink processing in the soft hand-off operation. The BSC 30 includes a control portion 32 and a selector portion 34.

In this example, it is assumed that the connection

lines 5_1 to 5_3 linking each BTS to the BSC 30 are duplex lines which carry respective uplink and downlink signals US and DS between the BTS concerned and the BSC. For example, a first connection line 5_1 carries respective uplink and downlink signals US1 and DS1 between the BTS1 and the BSC 30.

The selector portion 34 receives at its input a downlink signal DS supplied by the MSC (7 in Figure 5). The selector portion 34 has three outputs connected respectively to the connection lines 5_1 to 5_3.

The selector portion 34 also has a control input which receives a selection signal SEL. In response to the SEL selection signal the selector portion 34 connects its input to one, or all, of its three outputs.

The control portion 32 also has three inputs connected respectively to the connection lines 5_1 to 5_3 for receiving the uplink signals US1 to US3 from BTS1 to BTS3 respectively. The control portion applies the selection signal SEL to the selector portion 34.

In operation of the BSC shown in Figure 13, in each time slot of the uplink signal the control portion 32 receives one or more of the three uplink signals US1 to US3 from the BTSs involved in the soft hand-off operation. When the BSM supplied by the MS 40 is detected within a received uplink signal US1, US2 or US3, the control portion 32 examines the BSM and determines therefrom which of the BTSs is to be used to transmit the downlink signal in the next time slot to the MS 40.

If the BSM designates a single BTS, the control portion 32 sets the selection signal SEL such that the selector portion 34 supplies the downlink signal DS just to that one of the connection lines 5_1 to 5_3 connecting the BSC 30 to the designated BTS. If, on the other hand, all BTSs are designated by the BSM, the

selection signal SEL is set so that the downlink signal DS received from the MSC 7 is supplied to all of the connection lines 5_1 to 5_3.

It will be appreciated that it is not necessary for the downlink processing to be performed on a time slot-by-time slot basis. It could be performed on a frame-by-frame basis or the BTS selection could be made at some other suitable time interval.

It would also be possible for the signal selection information processing portion 48 (Figure 6) to include its own storage portion (similar to the storage portion 29 in Figure 8) enabling it to store a past history of the RSS (and/or SIR) measures for the different BTSs currently involved in the soft hand-off operation. In this case, as described previously in relation to the uplink processing, it would be possible for the MS to employ more sophisticated decision-making in relation to the BTS selection so as to avoid undesirable effects caused by temporary reception phenomena or other problems caused by too frequent-changing of the BTS selection.

It is not necessary for the mobile station to carry out the comparison of the signal measures for the different downlink signals and make the determination of the BTS to be used to transmit the downlink signal. The comparison and BTS determination could be carried out in the BSC; in this case instead of transmitting the BSM to the BTSs involved in the soft hand-off operation, the mobile station could transmit the downlink signal measures themselves (in some suitable form). These measures would then be delivered in the usual way to the BSC, enabling it to compare them and then make the BTS determination.

Although the present invention has been described above in relation to the proposed European wideband CDMA system (UTRA) it will be appreciated that it can

also be applied to a system otherwise in accordance with the IS95 standard. It would also be possible to apply the invention in other cellular networks not using CDMA, for example networks using one or more of the following: multiple-access techniques: time-division multiple access (TDMA), wavelength-division multiple access (WDMA), frequency-division multiple access (FDMA) and space-division multiple access (SDMA).

CLAIMS

1. A cellular mobile communications network including:

a mobile station;

a plurality of base transceiver stations, each for receiving uplink signals from the mobile station; and

base station controller means connected to the said base transceiver stations for receiving therefrom such uplink signals;

wherein the said mobile station is operable, during a soft hand-off operation involving more than one of the said base transceiver stations of the network, to include, in one or more such uplink signals transmitted thereby, respective signal measures for all of the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and

at least one of the said base transceiver stations includes soft hand-off control means operable, when that station is involved in such a soft hand-off operation, to determine, based on an assessment of the signal measure(s) for one or more of the other base transceiver stations involved in the soft hand-off operation, not to forward to the said base station controller means such an uplink signal received from the mobile station.

2. A network as claimed in claim 1, wherein each said base transceiver station of the network includes such soft hand-off control means which cooperate in such a way as to reduce the number of base transceiver stations involved in the soft hand-off operation that forward their respective received uplink signals to the said base station controller means.

3. A network as claimed in claim 2, wherein the said

soft hand-off control means in each base transceiver station determines not to forward the received uplink signal when the said signal measures indicate that one or more of the other base transceiver stations involved in the soft hand-off operation has a better communications-channel performance than the base transceiver station concerned.

4. A network as claimed in claim 2 or 3, wherein the said soft hand-off control means in each base transceiver station determines to forward the received uplink signal when the said signal measures indicate that the base transceiver station concerned has a better communications-channel performance than every other base transceiver station involved in the soft hand-off operation.

5. A network as claimed in any one of claims 2 to 4, wherein the said soft hand-off control means in each base transceiver station determines whether or not to forward the received uplink signal based on a rank of the base transceiver station concerned, in an order of ranking of the base transceiver stations involved in the soft hand-off operation, when the said signal measures indicate that the base transceiver station concerned and at least one other involved base transceiver station have comparably-good communications-channel performances.

6. A network as claimed in any one of claims 2 to 5, wherein the said soft hand-off control means in each base transceiver station determines to forward the received uplink signal when the said signal measures indicate that all the involved base transceiver stations have similar communications-channel performances.

7. A network as claimed in any one of claims 2 to 6, wherein the said soft hand-off control means in each base transceiver station determines not to forward the

received uplink signal when the base transceiver station concerned has requested the mobile station to increase its uplink transmission power and the said signal measures indicate that one or more other involved base transceiver stations has/have requested the mobile station to decrease its said uplink transmission power.

8. A network as claimed in any one of claims 2 to 7, wherein the said soft hand-off control means in each base transceiver station determines to forward the received uplink signal when the base transceiver station concerned has requested the mobile station to decrease its uplink transmission power and the said signal measures indicate that every other involved base transceiver station has requested the mobile station to increase its said uplink transmission power.

9. A network as claimed in any one of claims 2 to 8, wherein the said soft hand-off control means in each base transceiver station determines whether or not to forward the received uplink signal based on a rank of the base transceiver station concerned in an order of ranking of the base transceiver stations involved in the soft hand-off operation when the base transceiver station concerned has requested the mobile station to decrease its uplink transmission power and the said signal measures indicate that one or more other involved base transceiver stations has/have also requested the mobile station to decrease its said uplink transmission power.

10. A network as claimed in any one of claims 2 to 9, wherein the said soft hand-off control means in each base transceiver station determines to forward the received uplink signal when the base transceiver station concerned has requested the mobile station to increase its uplink transmission power and the said signal measures indicate that every other one of the

involved base transceiver stations has also requested the mobile station to increase its said uplink transmission power.

11. A network as claimed in any preceding claim, wherein the said soft hand-off control means makes the determination whether or not to forward the said received uplink signal based on a history of the said signal measures.

12. A network as claimed in any preceding claim, wherein the said signal measures are respective measures of the performance of an uplink communications channel from the said mobile station to the said base transceiver station concerned.

13. A network as claimed in claim 12, wherein each said base transceiver station is operable to measure such uplink performance and to transmit to the said mobile station control information derived from that measure, the said signal measure included by the mobile station for the base transceiver station concerned being derived from, or provided directly by, the said control information.

14. A network as claimed in claim 13, wherein the said control information is a power control command supplied by the said base transceiver station to the said mobile station for use in controlling an uplink transmission power of the said mobile station.

15. A network as claimed in claim 14, wherein the said power control command indicates whether the said uplink transmission power of the mobile station is to be increased or decreased.

16. A network as claimed in claim 5 or 9, wherein the said order of ranking of the involved base transceiver stations is determined by the mobile station, and the said mobile station transmits a ranking message to each involved base transceiver station to inform it of its rank in the determined ranking order.

17. A network as claimed in claim 5 or 9, wherein the said order of ranking of the involved base transceiver stations is determined by the base station controller means, and the said base station controller means transmit a ranking message to each involved base transceiver station to inform it of its rank in the determined ranking order.

18. A network as claimed in claim 5 or 9, wherein a first order of ranking of the involved base transceiver stations is determined by the mobile station, and the said mobile station transmits a first ranking message to each involved base transceiver station to inform it of its rank in the first ranking order, and a second order of ranking of the involved base transceiver stations is determined by the base station controller means, and the base station controller means transmit a second ranking message to each involved base transceiver station to inform it of its rank in the second ranking order, and the soft hand-off control means in each base transceiver station is operable to determine whether or not to forward the received uplink signal based on the respective ranks of the base transceiver station concerned in both the first and second ranking orders.

19. A network as claimed in claim 17 or 18, wherein the said order of ranking determined by the base station controller means is dependent upon one or more predetermined characteristics of communications paths used to connected the involved base transceiver stations to the said base station controller means.

20. A network as claimed in claim 19, wherein the said one or more predetermined characteristics include one or more of the following characteristics: congestion, availability, quality and cost of the communications paths.

21. A network as claimed in claim 16, wherein the said

signal measures are specified in a control message included in such uplink signals transmitted by the mobile station, the order of the said signal measures in the said control message corresponding to the said order of ranking determined by the mobile station.

22. A network as claimed in claim 11, wherein the said soft hand-off control means employs the said history to identify a "don't care" condition in which the current base transceiver station determination made by the soft hand-off control means is the same as the last such determination made thereby.

23. A mobile station, for use in a cellular mobile communications network, including:

transmitter means for transmitting uplink signals to a base transceiver station of the network; and

signal information processing means connected to the said transmitter means and operable, during a soft hand-off operation involving a plurality of such base transceiver stations of the network, to cause the said transmitter means to include, in one or more of the said uplink signals, respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned.

24. A base transceiver station, for use in a cellular mobile communications network, including:

receiver means for receiving uplink signals from a mobile station of the network, one or more of which uplink signals includes, when the mobile station is engaged in a soft hand-off operation involving the claimed base transceiver station and at least one further base transceiver station of the network, respective signal measures for all the base transceiver stations involved in the operation, each signal measure

serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and

soft hand-off control means operable, when the claimed base transceiver station is involved in such a soft hand-off operation, to determine, based on an assessment of the signal measure(s) for one or more of the other base transceiver stations involved in the operation, not to forward to base station controller means of the network such an uplink signal received from the mobile station.

25. A soft hand-off control method for use in a cellular mobile communications network, wherein:

when a soft hand-off operation involving more than one base transceiver station of the network is being performed, a mobile station of the network includes, in one or more uplink signals transmitted thereby, respective signal measures for all the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and

in at least one of the involved base transceiver stations, the signal measure(s) of one or more of the other base transceiver stations involved in the operation is/are assessed and a determination is made, based on the assessment, whether or not to forward to a base station controller of the network an uplink signal received from the mobile station.

26. A cellular mobile communications network including:

a mobile station;

a plurality of base transceiver stations, each for transmitting downlink signals to the said mobile station and for receiving uplink signals from the said mobile station; and

base station controller means connected to the said base transceiver stations for applying thereto such downlink signals;

wherein the said mobile station is operable, during a soft hand-off operation involving more than one of the said base transceiver stations of the network, to produce respective signal measures for all the base transceiver stations involved in the operation, each signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and

the network including base transceiver station selection means operable to employ the produced signal measures to determine which of the base transceiver stations involved in the operation should be used to transmit a subsequent one of the said downlink signals to the mobile station, and to cause that subsequent downlink signal to be transmitted by the base station controller means only to the said determined base transceiver station(s).

27. A network as claimed in claim 26, wherein:

the said mobile station is operable to employ the said produced signal measures to make the base transceiver station determination and to include, in such an uplink signal transmitted thereby, a base transceiver station selection message identifying the said determined base transceiver station(s); and

the said base station controller means are operable to receive the said uplink signal including the base transceiver station selection message and to transmit the said subsequent downlink signal only to the said determined base transceiver station(s).

28. A network as claimed in claim 26, wherein:

the said mobile station is operable to include the said produced signal measures in one or more uplink

signals transmitted thereby; and

the said base station controller means are operable to receive the said uplink signals including the said produced signal measures and to employ those measures to make the base transceiver station determination.

29. A network as claimed in any one of claims 26 to 28, wherein each said signal measure serves to indicate the performance of a downlink communications channel from the base transceiver station concerned to the mobile station.

30. A network as claimed in any one of claims 26 to 29, wherein the said base transceiver station selection means determine, when the said produced signal measures indicate that a single one of the involved base transceiver stations has a better communications-channel performance than all the other involved base transceiver station, that that single base transceiver station should be caused to transmit the said subsequent downlink signal to the mobile station.

31. A network as claimed in any one of claims 26 to 30, wherein the said base transceiver station selection means include ranking means for determining an order of ranking of the involved base transceiver stations, and are operable, when the said produced signal measures indicate that two or more of the involved base transceiver stations have comparably-good communications-channel performances, to select from amongst those two or more base transceiver stations based on the said order of ranking.

32. A network as claimed in any one of claims 26 to 31, wherein the said base transceiver station selection means determine, when the communications-channel performance of all the involved base transceiver stations fail to meet a prescribed requirement, that all the involved base transceiver stations should be

caused to transmit the said subsequent downlink signal to the mobile station.

33. A mobile station, for use in a cellular mobile communications network, including:

transmitter means for transmitting uplink signals to a base transceiver station of the network; and

signal information processing means connected to the said transmitter means and operable, during a soft hand-off operation involving a plurality of such base transceiver stations of the network, to produce respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned, and also operable to employ the produced signal measures to determine which of the involved base transceiver stations should be used to transmit a subsequent downlink signal to the mobile station, and to cause the said transmitter means to include, in such an uplink signal transmitted thereby, a base transceiver station selection message identifying the determined base transceiver station(s).

34. A base station controller, for use in a cellular mobile communications network to apply downlink signals to a plurality of base transceiver stations of the network, including:

receiver means for receiving uplink signals from one or more of the base transceiver stations, at least one of which uplink signals includes, when a mobile station is engaged in a soft hand-off operation involving more than one of the base transceiver stations of the network, a base transceiver station selection message identifying which of the involved base transceiver stations should be used to transmit a subsequent one of the said downlink signals to the

mobile station; and

soft hand-off control means operable to receive the said uplink signal including the base transceiver station selection message and to transmit the said subsequent downlink signal only to the said determined base transceiver station(s) identified in the message.

35. A soft hand-off control method for use in a cellular mobile communications network, wherein:

when a soft hand-off operation involving more than one base transceiver station of the network is being performed, a mobile station produces respective signal measures for all the base transceiver stations involved in the operation, each such signal measure serving to indicate the performance of a communications channel between the mobile station and the base transceiver station concerned; and

the produced signal measures are employed to determine which of the involved base transceiver stations should be used to transmit a subsequent downlink signal to the mobile station, and the said subsequent downlink signal is transmitted by base station controller means of the network only to the said determined base transceiver station(s).

36. A cellular mobile communications network substantially as hereinbefore described with reference to Figures 5 to 12 of the accompanying drawings.

37. A mobile station for use in a cellular mobile communications network, substantially as hereinbefore described with reference to Figures 5 to 12 of the accompanying drawings.

38. A base transceiver station for use in a cellular mobile communications network, substantially as hereinbefore described with reference to Figures 5 to 12 of the accompanying drawings.

39. A soft hand-off control method for use in a cellular mobile communications network, substantially

as hereinbefore described with reference to Figures 5 to 12 of the accompanying drawings.

40. A cellular mobile communications network substantially as hereinbefore described with reference to Figure 13 of the accompanying drawings.

41. A mobile station, for use in a cellular mobile communications network, substantially as hereinbefore described with reference to Figure 13 of the accompanying drawings.

42. A base station controller for use in a cellular mobile communications network, substantially as hereinbefore described with reference to Figure 13 of the accompanying drawings.

43. A soft hand-off control method for use in a cellular mobile communications network, substantially as hereinbefore described with reference to Figure 13 of the accompanying drawings.

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Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0577322 A1	(NOKIA) See col.6 lines 22-37	1,23-25,33-35 at least
X	WO 98/15152 A1	(ERICSSON) See p.27 lines 14-24; p.32 lines 16-21	"
X	WO 97/08911 A1	(NOKIA) See claims 1-4, p.6 lines 14-18	"
X	WO 95/32594 A1	(NTT) See claims 1-3, 6-8	"

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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(54)【発明の名称】　セルラ通信システム、及びそれに用いられる移動機と基地局

(57)【特許請求の範囲】

【請求項１】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムであり、

前記移動機は、

前記ソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質をモニタする下り受信品質モニタ手段と、

前記複数の下り受信品質モニタ結果に従って送信すべき基地局を指示する信号を送出する基地局指定手段と、

前記基地局指定信号を上り信号に多重化して前記複数の基地局に送信する多重化手段と、

前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含み、

前記基地局は、

前記上り信号に多重化された基地局指定信号を復調する復調手段と、

前記復調された基地局指定信号に従って、該当する移動機への下り送信信号の送信を制御する送信制御手段とを含むセルラシステム。

【請求項２】前記移動機の下り受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項１記載のセルラシステム。

【請求項３】前記基地局の送信制御手段は、基地局指定信号が自基地局では無い場合に送信を停止する請求項１記載のセルラシステム。

【請求項４】前記基地局の送信制御手段は、基地局指定信号が自基地局の場合および基地局指定信号に伝送誤りを検出した場合に送信を行う請求項３に記載のセルラシ

送信する多重化手段と、
前記ハンドオーバー状態にある複数の基地局からの受信信号を合成受信する受信手段とを含む移動機。
【請求項２１】前記移動機の受信品質モニタ手段は、前記基地局のそれぞれからすべての移動機に対して常時送信されるパイロットチャネルを用いて受信品質を測定することを特徴とする請求項２０記載の移動機。
【請求項２２】直接拡散符号分割多元接続方式を用いたセルラシステムであり、移動機が複数の基地局とソフトハンドオーバーを行うセルラシステムに用いられる基地局であり、移動機からの上り信号にその移動機とソフトハンドオーバー状態にある複数の基地局からの下り信号の受信品質のモニタ結果とそれに対応する基地局を示す信号とからなる副信号とが多重化された上り信号を受信する基地局であり、
前記副信号を復調する復調手段と、
前記復調された副信号に従って、自局の下り信号の送信を停止するか否かを示す送信停止信号を生成する送信停止信号生成手段と、
前記送信停止信号が送信停止を示しているときは、移動機への下り送信信号の送信を停止する送信制御手段とを含む基地局。
【請求項２３】前記送信制御手段は、前記副信号に誤りが検出されたときは、前記下り信号の送信を停止しない請求項２２に記載の基地局。
【請求項２４】前記送信停止信号生成手段は、すべての基地局の下り受信品質があらかじめ決められた値より小さい場合には、自局の下り信号品質が所定の順位以上であるときには、前記送信停止信号を出力しないことを特徴とする請求項２３に記載の基地局。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、移動通信システム、特に直接拡散符号分割多元接続（ＤＳ－ＣＤＭＡ）方式を用いた自動車電話・携帯電話システム（セルラシステム）のハンドオーバー技術に関し、属し、特に、移動機が複数の基地局と同時に接続されているソフトハンドオーバー時に、複数の基地局から移動機へ送信するための下り回線の送信電力制御技術に関する。
【０００２】
【従来の技術】本技術における従来技術としては、北米標準のＴＩＡ／ＥＩＡ　ＩＳ－９５に準拠した、符号分割多元接続（ＣＤＭＡ）方式を用いたセルラシステムが知られている。このＩＳ－９５標準では、ソフトハンドオーバーという技術が使われている。このソフトハンドオーバー技術が使用されるシステムでは、移動機がセル（またはセクタ）境界に近づいたときには、その移動機は、この境界近辺のセルをサービスエリアとする複数の基地局と同時に通信を行う
すなわち、移動機が現在通信中の基地局以外に受信レベルの大きい基地局を検出すると、移動機は自身がセル境界に近づいたと判断し、現基地局及び受信レベルが大きな他の基地局との複数の基地局との通信を開始する。そして、移動機は、複数の基地局から同じ下り情報を受信し、移動機では複数の基地局からの下り情報を最大比合成ダイバーシティ受信する。
【０００３】移動機の送信する上り情報は、複数の基地局で受信されてこれら複数の基地局を統括する基地局制御装置（ＢＳＣ；Base Station Contoller）に伝えられる。基地局制御装置は、これら複数の基地局で受信された上り信号を、最大比合成受信あるいは選択ダイバーシティ受信する。移動機がセル境界に位置するときは、基地局における上り信号の受信品質が低下するが、ＢＳＣにおいて複数の基地局の上り信号受信結果を合成あるいは選択ダイバーシティ受信することにより、この上り信号の受信品質低下を緩和できる。
【０００４】また、移動機がセル境界付近に位置すると、基地局からの距離が離れているので基地局からの下り信号の受信レベルが低下する。また、セル境界では、複数のセルからの干渉を受けるため回線品質が劣化しがちであるが、このように複数の基地局と接続する（ソフトハンドオーバー）ことにより、下り回線品質の劣化を防ぐことができる。
【０００５】
【発明が解決しようとする課題】しかしながら、ＩＳ－９５等の従来技術では、ソフトハンドオーバー中は、複数の基地局から下り信号を同時に送信していたため、ソフトハンドオーバー技術を使用しないセルラーシステムに比して、使用中の下り回線数が著しく増加する。すなわち、ソフトハンドオーバー中の移動機の台数が増えると、下り回線容量がネックとなって同時使用できる回線数が制限されるため、回線の有効利用が計れなくなるという潜在的な問題があった。
【０００６】しかるに、ＩＳ９５では、下り回線の伝送方式の方が上り回線の伝送方式に比べて効率が良かったため、上記のような複数の基地局から下り信号を送信するという、一見すると、非効率的な方法を用いても、下り回線容量がネックになることはなかった。
【０００７】しかし、現在、上り回線容量が下り回線容量と同等に改善されつつあるため、ソフトハンドオーバーによる下り回線容量の劣化を解決する必要が生じている。
【０００８】それ故に、本発明の主たる目的は、ＣＤＭＡ方式を採用した移動通信システムにおいて、セルあるいはセクタ境界に位置する端末に対するソフトハンドオーバー中の下り送受信方式を改良することにより、下り回線の効率を向上することができるソフトハンドオーバー方式を提供することにある。
【０００９】
【課題を解決するための手段】本発明は、直接拡散符号

【００２１】移動機（ＭＳ）３０３が、基地局（ＢＳ１）３０１のサービスエリアから基地局（ＢＳ２）３０２のサービスエリアに移動し、２つの基地局３０１，３０２のサービスエリアが重なる部分に位置すると、基地局（ＢＳ２）３０２は、移動機からの上り信号が受信可能となり、基地局（ＢＳ２）３０２は、移動機３０３からの上り信号の受信が可能になった旨を基地局制御装置に伝える。すると基地局制御装置は、基地局（ＢＳ１）３０１からの上り信号と基地局（ＢＳ２）３０２からの上り信号とを最大比合成受信あるいは選択ダイバーシティ受信して、その結果を移動通信用交換機（ＭＳＣ）に転送する。また、基地局制御装置は、それまで基地局（ＢＳ１）３０１にのみ伝えていた移動通信用交換機から移動機３０３への下り信号を、基地局（ＢＳ２）３０２にも転送する。この動作については、ＩＳ－９５標準等に規定された従来技術と同様である。

【００２２】次に、本発明の根幹をなす、移動機及び基地局の下り信号に対する動作につき説明する。この図３の例では、前述した選択基準は、全て一致することとなり、良い受信品質を示した方の基地局のみが選択され、選択されなかった基地局は、移動通信用交換機（ＭＳＣ）、基地局制御装置（ＢＳＣ）を介して供給された下り信号の送信を停止する。

【００２３】基地局３０１、３０２の送信制御手段２０７は、基地局指定信号が自基地局を指定していない場合には、送信を停止する。また、送信制御手段２０７は、基地局指定信号が自基地局を指定している場合および基地局指定信号に伝送誤りを検出した場合に移動機への送信を行い、それ以外の場合に送信を停止する。

【００２４】図４は、この時の基地局３０１および基地局３０２の下り受信品質の遷移、および、各基地局（ＢＳ１，ＢＳ２）３０１，３０２の送信ＯＮ／ＯＦＦのタイミングを示すタイムチャートである。

【００２５】従来方式（例えばＩＳ９５）では、図４ａ）、ｂ）に示されるとおり、２つの基地局の受信品質差が一定値より小さくなるとソフトハンドオーバー状態に入り、２つの基地局で移動機に送信を開始する。このソフトハンドオーバー状態は、２つの基地局の受信品質差が一定値以上に開き、完全に新しい基地局（ＢＳ２）３０２のサービスエリアに入るまで継続される。すなわち、従来例では、ソフトハンドオーバー中は２つの基地局で送信を行っている。

【００２６】一方、図４ｃ）～ｅ）は本発明の一実施例における、基地局指定信号および２つの基地局（ＢＳ１，ＢＳ２）３０１，３０２の送信ＯＮ／ＯＦＦのタイミングを示している。ハンドオーバー中も受信品質の変化に伴って、基地局指定信号が変化し、常に伝搬状態の良い片方の基地局からのみ送信が行われることを示している。

【００２７】この図３の例における、ソフトハンドオーバーの手順は次の通りである。

［１］従来技術と同様に、移動機３０３は周辺基地局のパイロットチャネルの受信品質を測定し基地局に報告する。現在通信中の基地局のパイロットチャネルの受信品質と一定差以内の基地局が検出されると、ソフトハンドオーバー状態に入る。

［２］基地局より、ソフトハンドオーバー状態の基地局とその番号を移動機に通知する。

［３］ソフトハンドオーバー状態の複数の基地局は、従来と同様、移動機の上り情報を最大比合成あるいは選択ダイバーシティ受信する。

［４］移動機はソフトハンドオーバー状態の基地局のパイロットチャネルの品質をモニタし、最も品質の良い基地局の番号を上り回線の付随制御チャネルを用いて、ソフトハンドオーバー状態の全基地局に通知する。品質測定・通知は、レイリーフェージングに追従する必要はなく、建物の陰に入る等の伝播経路の変化（シャドウイング）に追従できればよい。

［５］移動機３０３に指示された基地局のみ下り情報を送信する。上り回線の誤り等により、１局も下り情報を送信しない危険があるが、付随制御チャネルのＣＲＣで誤りを検出した基地局でも送信する等の方法により避けることが可能である。

［６］移動機３０３は複数の基地局からの信号を選択あるいは最大比合成により受信する。

［７］パイロットチャネルの受信品質の差が一定値以上になったときは、ソフトハンドオーバ状態を解除する。

【００２８】このような手順で基地局および移動機３０３が動作する事により、ソフトハンドオーバー状態でも、伝搬品質の良い一部の基地局のみが、下り送信を行うことになり、伝搬品質の悪い基地局からは下り送信を行なわなくて済むため、下り回線の周波数利用効率を改善することができる。

【００２９】移動機３０３は、基地局サーチおよび同期検波を行うために、基地局毎に全回線で共通利用するパイロットチャネルを用いて下り回線品質の測定を行うため、送信停止状態の基地局の下り回線品質もモニタ可能である。したがって、移動機は、その移動機に対する下り通信を停止している基地局に、下り送信の再開をしじできる。

【００３０】複数の基地局の下り回線品質がほぼ同等で、最大比合成により複数の基地局からの受信信号を無駄なく合成可能と判断した場合は、移動機３０３は該当する複数の基地局に対して下り送信を指示することにより、ダイバーシティゲインを得ることも可能である。

【００３１】また、すべての基地局の下り回線品質がすべて劣化しており、１局の送信では所要品質を満たすことができないと判断した場合は、移動機は受信品質が比較的良い複数の基地局に対して下り送信を指示することにより、所要受信品質を得ることが可能である。

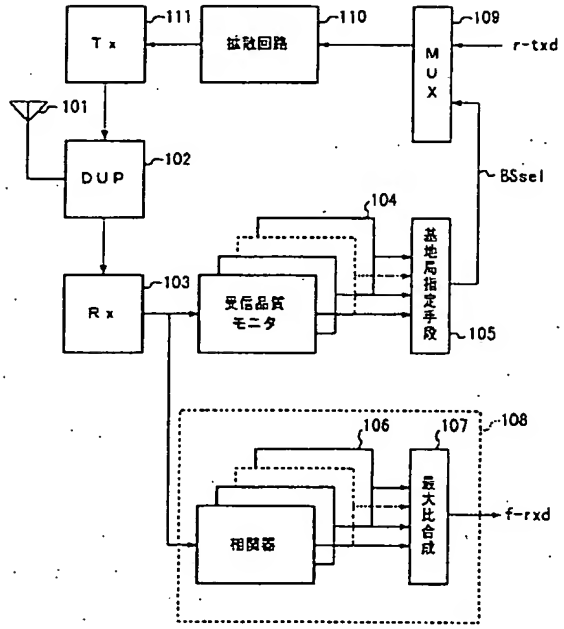
示すブロック図である。

【図６】本発明の第２の実施形態に係る基地局の構成を示すブロック図である。

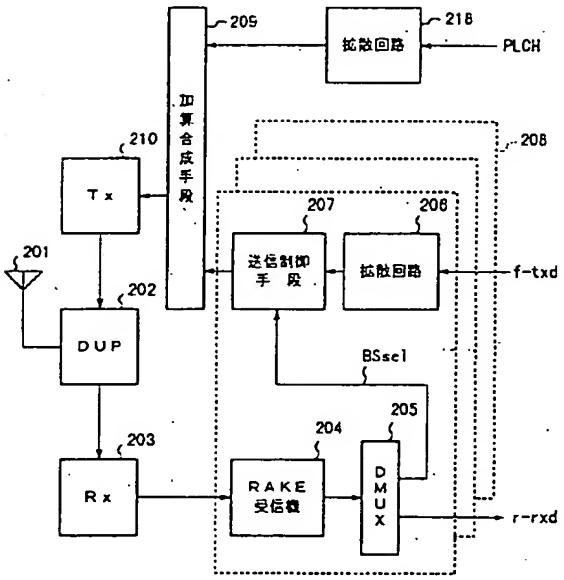
【符号の説明】

１０１、２０１　アンテナ
１０２、２０２　送受共用器
１０３、２０３　無線受信部
１０４　受信品質モニタ手段
１０５　基地局指定手段
１０６　相関器
１０７　最大比合成器
１０８、２０４　ＲＡＫＥ受信機
１０９　マルチプレクサ
１１０、２０６、２１８　拡散回路
１１０、２１０　無線送信部
２０５　デマルチプレクサ
２０７　送信制御手段
２０８　チャネル部
２０９　加算器
３０１、３０２　基地局
３０３　移動機

【図１】



【図２】



【図６】